Training and Pruning Fruit Trees

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INTRODUCTION

The main objective of training and pruning fruit trees is to develop a proper canopy shape and framework, which gives the leaves adequate exposure to sunshine.

The early shaping of the tree framework by limb positioning is referred to as training. In contrast, pruning is the removal of unwanted wood. Training should be emphasized over pruning during the years of canopy formation. Once the main framework of the fruit tree has been established, pruning is used to maintain good light penetration and correct vigor throughout the tree canopy. Proper training and pruning, coupled with good orchard management practices, will insure production of fruit with good quality, size and color.

The choice of cultivar, rootstock, tree density and management practices for different fruit crops will determine the training and pruning system. In order to apply these principles successfully and obtain satisfactory tree performance and productivity, it is essential to understand tree response to training and pruning.

In this publication, the basic principles of tree response to training and pruning are discussed. It should be noted that these responses are **always** applicable, irrespective of the training or pruning system used. The different physiological responses to training and pruning of various fruit species is also emphasized.

TRAINING AND PRUNING PRINCIPLES

1. Pruning reduces tree size and stimulates growth near the cut

Pruning reduces tree size. Severe pruning increases this dwarfing effect, yet stimulates even more vigorous shoot growth near the cuts. In young trees, pruning cuts should complement appropriate development of the permanent canopy structure.

2. Training and pruning should emphasize good scaffold limb development

Training and pruning practices should encourage well-developed and properly positioned scaffold limbs. Where an excessively upright growth habit prevails, limb spreaders may be used to position scaffold limbs at a 45–60° angle. Positioning scaffolds at these angles eliminates the interference of lower limbs with the development of those above, helps reduce vegetative vigor, stimulates flowering and gives greater flexibility when scaffolds carry a heavy load of fruit. However, bending limbs to near or below the horizontal virtually eliminates lateral extension growth and stimulates undesirable upright watersprouts.

3. Pruning and training should be balanced for maximum canopy development

For two to three years after the tree is planted, only minimum pruning should be carried out while emphasizing tree training for good canopy development. At this stage, effort should be directed at controlling the growth of the central leader and encouraging the development of scaffold limbs. Excessive pruning will encourage excessive vegetative vigor and delay canopy expansion. This condition may also predispose trees to low-temperature injury, reduce flower-bud initiation and delay early fruit production.

4. Wide-angled crotches are preferred

Narrow-angled crotches do not become stronger as the tree grows because bark is trapped in the angle between the trunk and branches, preventing normal wood development in this area. The tissues in narrow-angled crotches are slow to mature in the fall and may be damaged by low winter temperatures. Narrow crotches may also offer points of entry for boring insects or disease organisms. In contrast, wide-angled crotches continue to strengthen as the scaffold limbs enlarge, permitting heavy crop loads to be carried without limb breakage.

5. Dormant vs. summer pruning

Most pruning is carried out when trees are dormant. The ideal time for dormant pruning is in the early spring just before bud-swell. Orchard size permitting, dormant pruning should be delayed past the coldest part of the winter to avoid damage from severe winter freezes. If possible, the pruning of young or vigorous trees should be delayed until the end of the winter. It is not advisable to prune trees while the wood is frozen. If a severe winter freeze has caused shoot dieback, wood discoloration or crotch injury, pruning should be delayed until late spring when growth has started. At this time, prune back to the healthy tissue.

Pruning during the dormant season does not apply to peach and nectarine trees. For details on pruning requirements of these crops refer to the "Training and Pruning Peach and Nectarine Trees" section.

Summer pruning usually refers to pruning after growth has started. Pruning in late spring and after the beginning of the spring flush is very debilitating to a tree and should be employed only after careful consideration of the consequences. Pruning at this time stimulates excessive regrowth and inhibits flower-bud formation. Normal summer pruning is usually delayed until late July or August which, unless it is very heavy, usually has little effect on tree vigor and regrowth. It should be noted that any stimulation of regrowth may adversely affect the development of winter hardiness in the fall.

6. Effects of different pruning cuts

The pruning cut should be nearly flush with the branch or the bud that is left to grow. The cut should be made in a way to expose a wound of the smallest diameter. Protruding stubs never heal properly and may start to decay.

Essentially there are two different types of pruning cuts: **heading-back** and **thinning-out**. With a heading-back cut, only a portion of a shoot or branch is removed. Production of vigorous new shoots is stimulated immediately below the cut. When old wood is headed-back, it changes fruit spurs to vegetative shoots and initially reduces fruit-bearing surface. This practice is especially useful in spur-bound trees, through which the total surface-bearing area of the tree may be increased in two- to three-years time.

A thinning-out cut is used to completely remove a shoot or branch to its base. These cuts promote spur formation and improve light distribution in the tree canopy, but do not disrupt internal hormonal relations. Therefore thinning-out cuts produce much less shoot growth.

7. Pruning influences the balance between vegetative growth and fruiting

Since fruit compete with vegetative tissues and roots for nutrients, heavy fruiting restricts vegetative growth (especially root growth). Pruning that removes fruit-bearing wood affects this relationship by shifting the balance away from fruiting and toward wood formation. Pruning can delay flower-bud formation and fruiting by stimulating shoot growth in the young tree. In the older tree, pruning decreases cropping, thereby favoring greater allocation of photosynthates to wood development. Heading-back cuts generally affect this balance more than comparable thinning-out cuts. The actual degree of effect on the vegetative/fruiting balance will depend on the nature and severity of the pruning job. All pruning should be minimized, yet still fulfill the desired objectives.

Apple

L.C. Elfving

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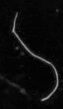
Apple



L.C. Elfring

TRAINING AND PRUNING APPLE TREES

Introduction

Today, Ontario apple growers face increasing competition in the marketplace, both from other production areas in Canada and abroad. The fresh-apple market demands large apples of uniform size, well-colored fruit with proper maturity and satisfying flavor. Competition in the processed-apple market, especially from foreign producers, is also intense. To prosper in this competitive economic climate, Ontario apple growers must produce higher quality apples more efficiently.

Many factors influence fruit size, quality and production efficiency. Among these, tree size, shape and structure play a critical role. Tree size is a function of many factors, including cultivar, rootstock, soil, site, and management practices. Tree shape and structure are largely determined by proper implementation of tree training and pruning techniques. Therefore, application of these methods, both in the early years and at maturity, is critical to effective apple growing.

Physiological Aspects of Training and Pruning Apple Trees

A. Light and Tree Form

The energy source for tree growth is light energy which is absorbed by leaves. Light is not only important for carbohydrate production, it also stimulates flower-bud formation and induces color development in the skin of the fruits. Since each apple leaf absorbs approximately 90% of the radiation to which it is exposed, upper leaves tend to receive more light than lower leaves which are shaded. This produces several distinct zones of different light exposure in the tree canopy (Figure 1). In zones one and two, light levels are at or above what are needed for maximum photosynthesis, flower-bud formation and the development of good fruit size and color. When light levels in the canopy fall to below 30% of full sun (zone three), flower-bud formation is reduced, spur vigor is lost and any fruits which develop are of poor color and small size. After several years of exposure to low light levels, the weakened spurs and shoots in zone three usually die or are removed completely and production from the interior of the tree is lost. Tree size has a significant effect on the amount of poorly illuminated leaf area within the canopy of an apply tree. The zone of inadequate light can vary from as much as 25% in a large, standard-size tree to as little as 8% or less in a dwarf tree.

In addition to tree size, the shape and structure of the canopy significantly affect light distribution within a tree. A globular canopy shape, typical of most standard trees, causes substantial in-tree shading (Figure 1a). A conic or pyramidal shape, with the upper limbs restricted in spread relative to the lower limbs, produces the most favorable light distribution (Figure 1b). This structure minimizes in-tree shading from above. The conic shape has the additional advantage of maintaining the majority of the canopy volume closer to the ground

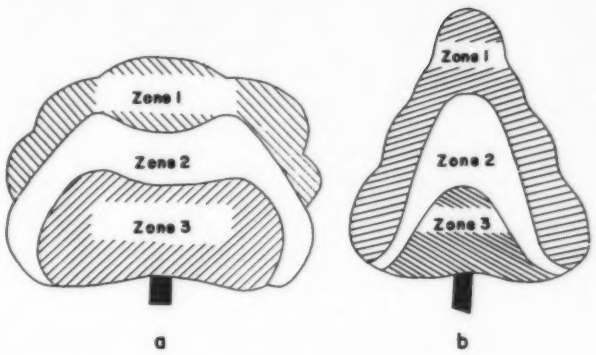


Figure 1. Distinct zones of light exposure form in the canopy of an apple tree due to shade cast by the canopy itself. A globular canopy shape (a) produces much more internal shading (zones 2 and 3) than a conic shape (b).

which permits easier pruning, spraying and harvesting operations. For these reasons, the conic tree shape is preferred for free-standing trees where canopy structure is not dictated by a specific support system.

A conic tree shape requires a central leader for support of the fruiting limbs. Also, it requires a system of fruiting scaffold limbs distributed both vertically along and circumferentially around the leader. The upper limbs are not permitted to overgrow and therefore shade the lower part of the canopy. Such conic trees will permit maximum light penetration throughout the canopy.

An open tree structure contains well-spaced scaffold limbs with a minimum amount of upright growth, leaving considerable open space for light channels into the canopy. This structure provides better light distribution, minimizing the zone of inadequate light penetration; it also enhances spray distribution and access to fruit at harvest time.

B. Growth in the Apple Tree

In the spring, before a large leaf area has developed, the tree is still dependent on stored resources from the previous year. However, shortly after shoot growth begins, the leafy canopy develops sufficiently to meet all the carbohydrate requirements of the tree. The expansion of shoots and leaves, the enlargement of fruits, the thickening of branches and the trunk, and the development of roots are all growth processes supported by the products of the leaves.

Since many different parts of the tree are in active growth simultaneously, growing points compete with one another for carbohydrates. Actively growing fruits divert carbohydrates away from other growing points, reducing all forms of vegetative growth and thereby contributing to control of tree size

(Table 1). However, these reductions in vegetative growth of different parts of the tree are not equal. The growing points further away from the leaves grow proportionately less, illustrating the competitive interaction among growing points for carbohydrates. Although shoot growth is the most visible form of vegetative growth in a tree, other less visible forms have a much greater influence on tree productivity. A large, standard tree may devote about the same amount of its total seasonal resources to growth of woody tissues as it will to fruit (Table 2). Shoot growth, however, accounts for only a very small fraction of the total seasonally-fixed dry matter. The effect of tree size on growth allocation among growing points illustrates the significance of structural wood in determining production efficiency (Table 2). Smaller apple trees direct a much higher proportion of their dry matter production into fruit because of the absence of a large quantity of structural wood. Therefore, not only do smaller trees have better light distribution and a more easily managed canopy, but they also direct a much higher percentage of their resources into fruit production. These reasons help to explain why apple growers are rapidly changing from large to small trees.

Table 1. Effect of Fruit on Growth of Vegetative Components of Apple Trees Compared to Growth of Defruited Trees.

Tree component	Percent reduction in annual new growth of component brought about by fruiting
Leaves	−30
New shoots	−35
Structural wood (branch and trunk thickening)	−48
Roots	−76

Source: Maggs, 1963. J. Hort. Sci. 38:119–128

Table 2. Effect of Tree Size on Distribution of Photosynthetically Produced Dry Matter Among Aboveground Components of 'McIntosh' Apple Trees.

	Percent of total annual aboveground dry-matter increase contained in component	
Tree component	Large tree (Seedling rootstock)	Semi-dwarf tree (M. 7 rootstock)
Leaves	14	9
New Shoots	4	2
Structural wood (branch and trunk thickening)	37	12
Fruit	45	77

Source: Forshey and McKee, 1970. HortScience 5:164–165

Principles of Training and Pruning Apple Trees

A. Training vs. Pruning

Pruning is the removal of growing points, potential or actual leaf surface, and reserve materials stored in the bark and wood. For these reasons, pruning is considered a dwarfing process. Some pruning cuts stimulate vigorous shoot growth, producing the illusion of increased growth. Nevertheless, actual growth from a pruned branch is never equal to the sum total of the wood removed plus the growth it would have made.

During the early years of canopy development, emphasis should be placed on tree training, directing growth into a permanent structure, rather than on pruning. Proper development of the central leader and scaffold limbs should be the primary objective. A wide crotch angle should be established for each scaffold limb. Where necessary, scaffold limbs should be positioned with spreaders to direct their growth into the assigned space in the canopy. Pruning should be limited to those cuts needed to remove unwanted wood and to help direct growth into the permanent canopy structure.

As the tree matures, the pruning program should shift from framework establishment to the maintenance of a productive canopy. Pruning should be used to maintain an open canopy and to retain the conic canopy shape by restricting the spread of upper limbs in relation to lower limbs. Very vigorous or very weak wood should be removed to maintain as nearly uniform vigor as possible throughout the canopy. Maintenance of uniform light exposure within the canopy facilitates maintaining uniform vigor. Successful training and pruning requires an understanding of how trees grow, the effects of pruning cuts on tree response, and proper application of this knowledge to the varied circumstances existing in the orchard.

The pruning program should be carefully planned in advance of the pruning season. Depending on cultivar, rootstock, site and management conditions, it may be necessary to apply a variety of pruning practices to achieve the objectives outlined above. An appropriate blend of training and pruning techniques correctly applied to the different circumstances in the orchard will help to assure the production of good quality fruit throughout the life of the orchard.

B. Growth Responses to Pruning Cuts

Both branch orientation and pruning affect shoot growth in an apple tree. An understanding of these phenomena is basic to the development of an appropriate pruning program. In apple trees, upright (vertical) branches are strongly vegetative and exhibit extensive terminal-shoot growth (Figure 2). The amount of lateral branching will depend on cultivar and tree vigor, but is often sparse in upright limbs. Orientation of such a branch to a near-horizontal position will decrease the dominance of terminal growth. As terminal growth is reduced, overall branch vigor is also reduced. More lateral branching will occur in a branch that is nearly horizontal, and these lateral shoots will tend to be less vigorous and more fruitful. In addition, proper branch orientation stimulates flower-bud formation and early fruit production. When a branch is oriented with the tip below the horizontal position, terminal

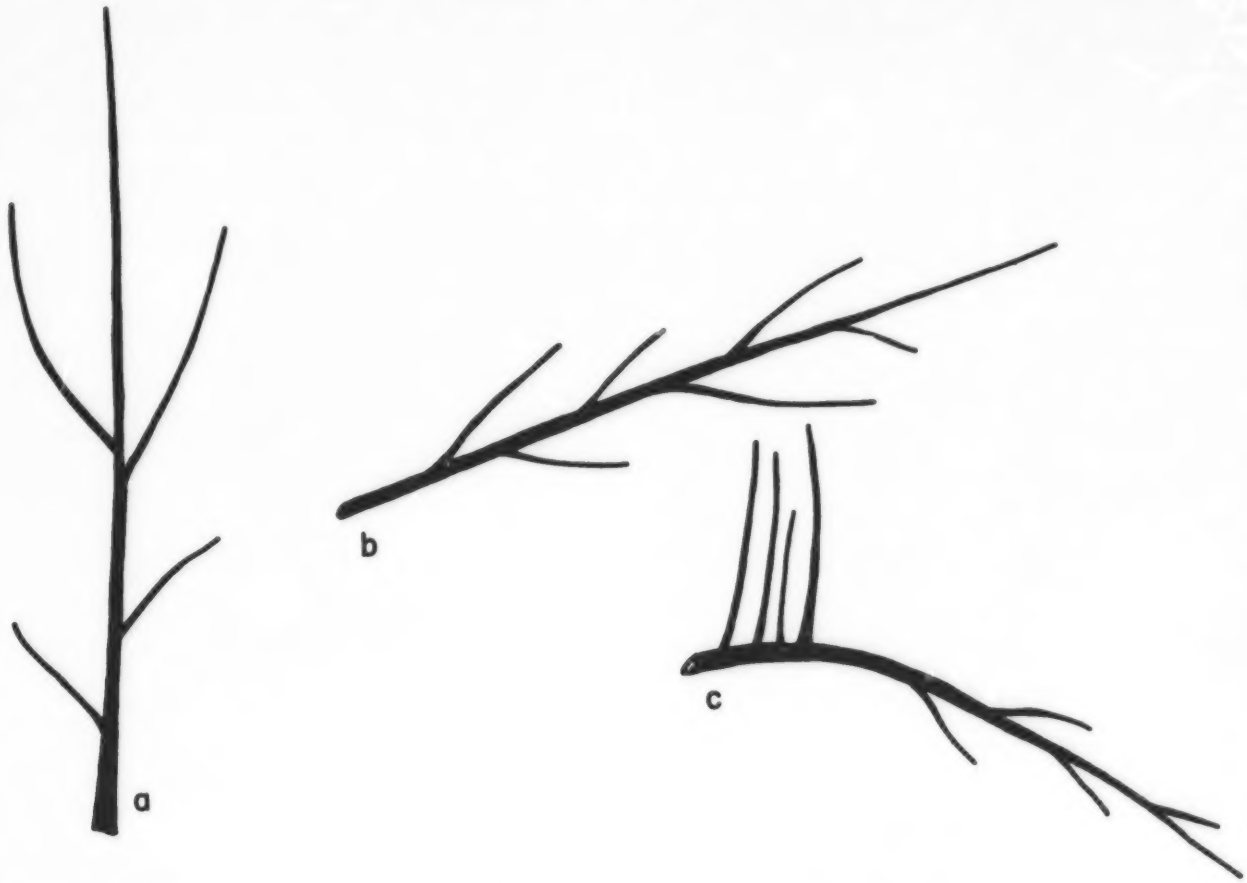


Figure 2. Response of branch growth to limb orientation. Vertical branches (a) produce vigorous growth. Vigor is reduced, secondary branching is improved and flowering is stimulated in limbs positioned near the horizontal (b). A limb oriented below the horizontal position (c) grows weakly, but suckering is stimulated near the point of bending.

extension virtually ceases. Apical dominance is lost and growth tends to be concentrated in a series of vigorous, upright shoots which develop near the point where the branch is bent (Figure 2).

Pruning cuts can be divided into two convenient categories, **heading-back** and **thinning-out** (Figure 3). A heading-back cut removes a portion of a branch in the vicinity of a bud or spur. In contrast, a thinning-out cut removes an entire branch section at its junction with the remainder of the branch.

Heading-back cuts interrupt the flow of natural growth regulators in a branch. This change induces several buds near the cut to initiate vigorous vegetative growth. The actual amount of vegetative growth, however, depends both on the inherent vigor of the branch and its orientation.

The heading-back of an upright branch produces a substantial increase in shoot growth near the cut as well as further down on the branch itself. In a near-horizontal branch, a heading-back cut does not alter total vegetative growth as much, but stimulates more of the potential shoot growth near the cut. Similarly, a heading-back cut in a branch oriented below the horizontal position increases vegetative growth near the point of the cut, with little effect on overall growth.

Thinning-out cuts have a relatively minor effect on the hormonal system of a branch. For this reason, a thinning-out cut usually produces a relatively small response in vegetative growth, irrespective of branch orientation.

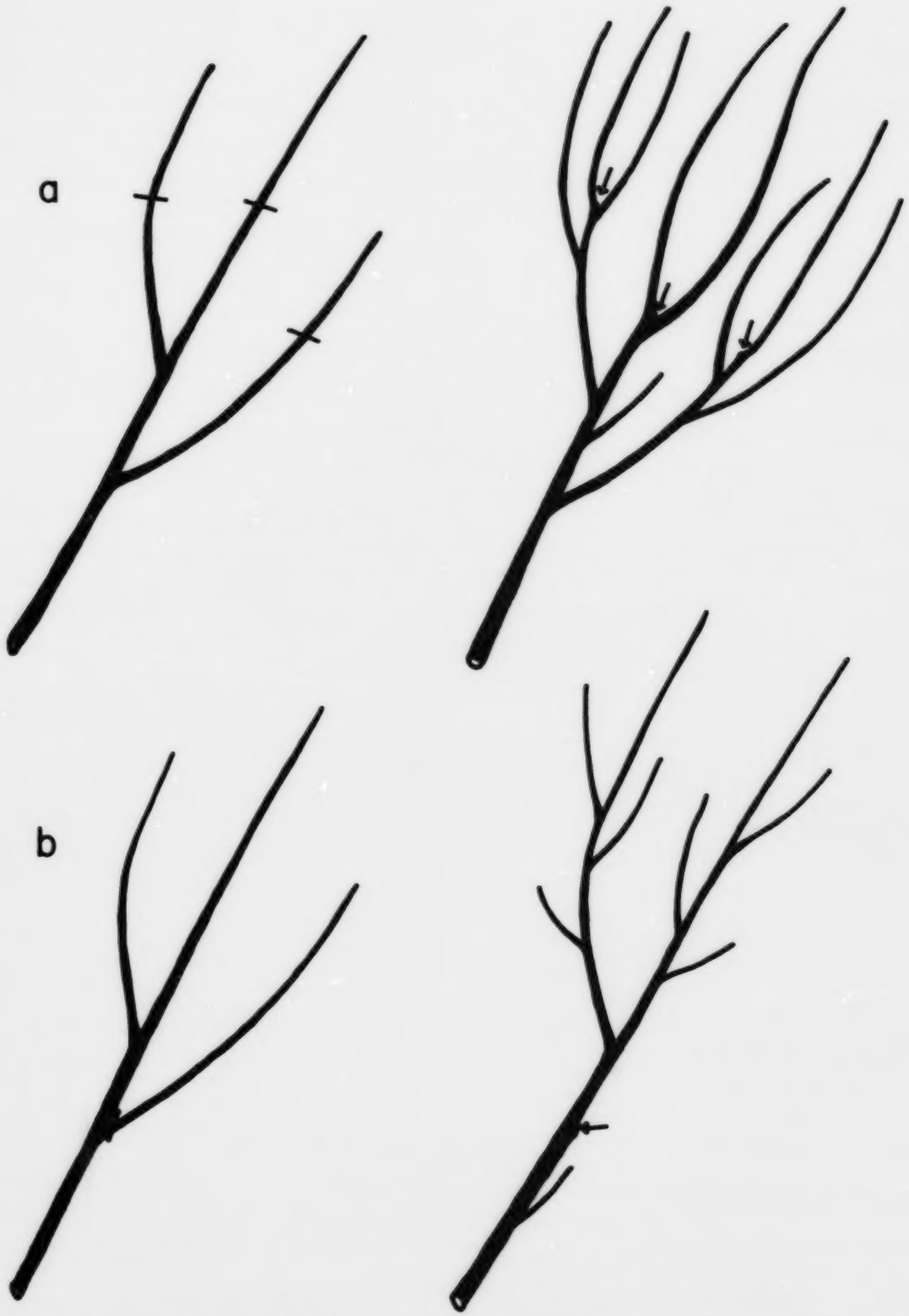


Figure 3. Effects of heading-back (a) and thinning-out (b) cuts. Heading-back stimulates strong vegetative growth and delays flowering. Thinning-out has only a modest stimulating effect on growth.

Principles of Training and Pruning the Young Free-standing Apple Tree

Two requirements are necessary to develop the conic-shaped canopy of a free-standing tree. First, a strong, upright central leader must be developed that is capable of supporting the fruiting canopy. This central leader must reach a height sufficient to permit scaffold limbs to fill the assigned space in the orchard. Second, a set of correctly positioned and well-structured scaffold limbs must be developed from the central leader to fill the assigned space with fruiting wood.

Where possible, emphasis in the early years should be on training and directing growth into the desired canopy structure. Pruning should be limited to removal of unwanted, and broken or damaged branches. The specific training and pruning requirements will vary from year to year depending on the cultivar, rootstock, and tree vigor. Since scaffold limbs rarely develop in an ideal position for optimum light exposure and heavy fruit production, every effort should be made to establish wide crotch angles, to spread scaffolds, and to develop secondary branches and fruit spurs. Some cultivars, such as 'Empire' and 'Idared', produce a spreading canopy which requires minimal additional training. Cultivars such as 'Delicious', 'McIntosh', 'Spartan' and most spur-type strains tend to produce vigorous upright growth. In such trees, extensive efforts are required to establish an acceptable canopy structure and shape.

While precocity (early cropping) is a common feature today among cultivars on dwarfing and semi-dwarfing rootstocks, excessive early cropping withdraws carbohydrate resources from vegetative growth and may even force the scaffold limbs or the leader out of position. Uncontrolled early cropping can seriously distort tree structure, prematurely restrict vegetative growth and interfere with the continued development of the canopy.

A. Central Leader Development

Establishment of the central leader begins at planting and continues until the tree reaches its final height. A two-step process should be applied each year to assure strong, upright central leader development. The leader shoot should be headed-back each spring by removing about one-quarter to one-third of its length (Figure 4). Heading-back the central leader during the dormant pruning period forces the vigorous growth of several upright shoots from the buds adjacent to the cut. The growth of these shoots causes the natural production and downward movement of auxin hormones. These hormones stimulate lower lateral shoots to form wider crotch angles. Since some of these lower shoots will be selected as scaffold limbs during the next dormant season, wider crotch angles are a definite advantage.

Once the vigorous, upright shoots originating from the central leader have reached 10–15 cm (4–6 inches) in length, a single shoot should be selected to continue the central-leader formation and the others removed (Figure 4). At this stage of development these shoots can be cut out easily with hand shears. Manual removal may seriously damage the remaining leader. Removal of competing upright shoots from the leader not only helps maintain its dominance, but also permits better development of the lateral shoots below, which will become

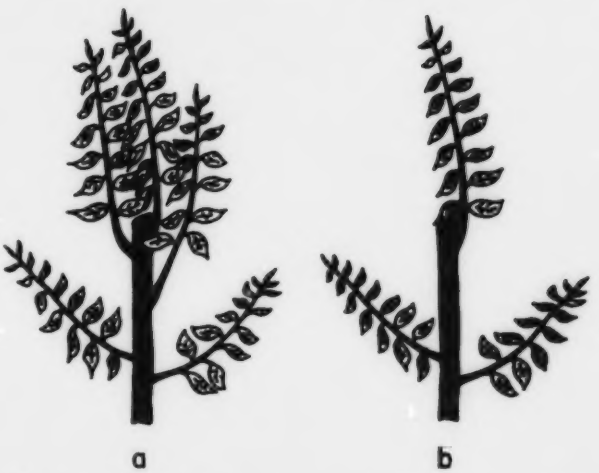


Figure 4. Heading-back the central leader stimulates strong vegetative growth but does not produce a single dominant shoot (a). Leader selection (b) removes competing upright shoots, assuring leader dominance and enhancing development of scaffold limbs.

the future scaffold limbs (Figure 5). This process of leader management should be continued until the trees reach their intended height.

B. Scaffold Limb Selection

Selection and development of the scaffold limbs is the most important process in the training and pruning of a young apple tree. Strong, well-formed scaffold limbs are the key to an efficient tree shape and to heavy fruit production. The process begins with the formation of wide crotch angles (Figure 6). A wide crotch angle for scaffold limbs is essential to support heavy crops of fruit at maturity. A narrow crotch contains a bark inclusion. This structure represents a point of weakness, and also permits decay organisms or other pests to enter the tree tissue. Limbs with such crotches often break when heavily loaded with fruit. In contrast, a wide crotch angle continues to strengthen as the scaffold limb enlarges, permitting heavy fruiting without limb breakage.

The lowest scaffold limb should be at least 45 cm above the ground to permit orchard equipment to pass without causing damage to the tree; any lower growth should be removed. Scaffold limbs in the first tier should be vertically separated from each other on the trunk by at least 10–20 cm (4–8 inches) and should be oriented toward different quadrants in the space assigned to that tree (Figure 7). A full tier of scaffolds contains three or four limbs well distributed around the trunk. It is important that several scaffolds are not positioned very close

Figure 5. The effect of vigorous growth on crotch angles following heading-back of central leader. The leader was headed while dormant and leader selection carried out at the correct time. Note the continued dominance of the central leader and strong growth of scaffold limb candidate shoots below.

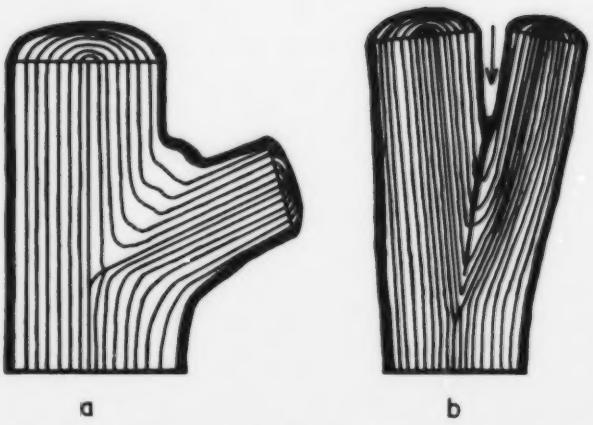


Figure 6. Structure of wide (a) and narrow (b) crotches. The narrow crotch is structurally weak and contains a bark inclusion (arrow), an entry point for insects or diseases (modified from Cornell Agr. Expt. Sta. Bull. 419, 1923).

together on the tree trunk. When this situation occurs, the growth of the scaffold limb bases may restrict the flow of nutrients to the central leader, thereby weakening it. Loss of central leader dominance will result in the formation of an undesirable globular canopy (Figure 8).

As the tree develops, additional tiers of scaffolds are selected so that the limbs intersect the quadrants occupied by scaffolds in the tier below (Figure 9). Each tier of scaffolds should be separated from the tier below by at least 20 cm (8 inches) and each new scaffold limb should be spaced vertically from its nearest neighbor by 10–20 cm (4–8 inches) as described previously. A minimum distance of 60–100 cm (2–3 ft) should separate scaffold limbs directly above one another. This approach assures sufficient space between scaffolds to allow good light penetration within the canopy interior and easy access to the fruit at harvest.

Vigorous vegetative growth should be maintained in the lower scaffold limbs so that upper scaffolds do not extend beyond the lower limbs, thus increasing interior shading. Some cultivars tend to produce very upright growth; for such cultivars, scaffold limbs should be spread. This process usually begins in the second year of growth in the orchard. Limb spreading has several important beneficial effects: (1) it helps maintain the dominance of the central leader by controlling vegetative vigor; (2) it prevents interference from lower scaffold limbs in the development of scaffolds higher in the tree; (3) it favors improved lateral bud break, spur formation, lateral branching and flowering; (4) it enhances early productivity and improved fruit quality; and (5) it may help to improve crotch angle and structure. Limbs should be positioned to no greater than 45–60° from the vertical position. This will prevent formation of upright watersprouts and allow for some limb flexibility when heavy crops of fruit are produced. If the limb is spread too far, fruiting will cause the limb to bend below the horizontal position, virtually eliminating extension growth and creating the possibility of excessive upright watersprout formation.

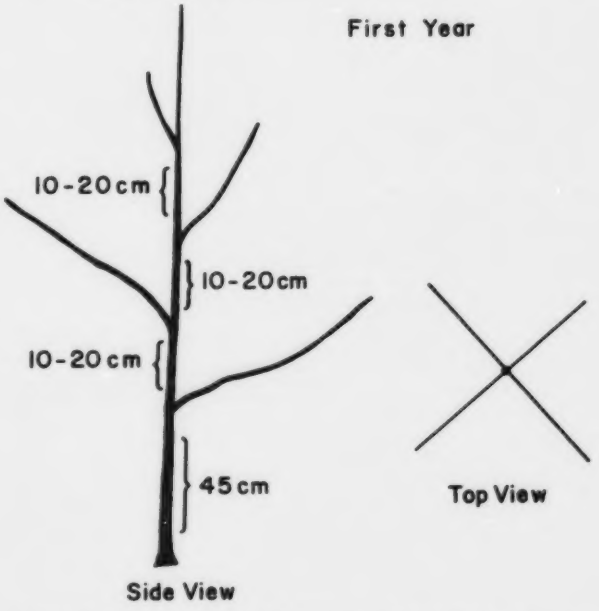


Figure 7. Selection of scaffold limbs during the first year in the orchard.

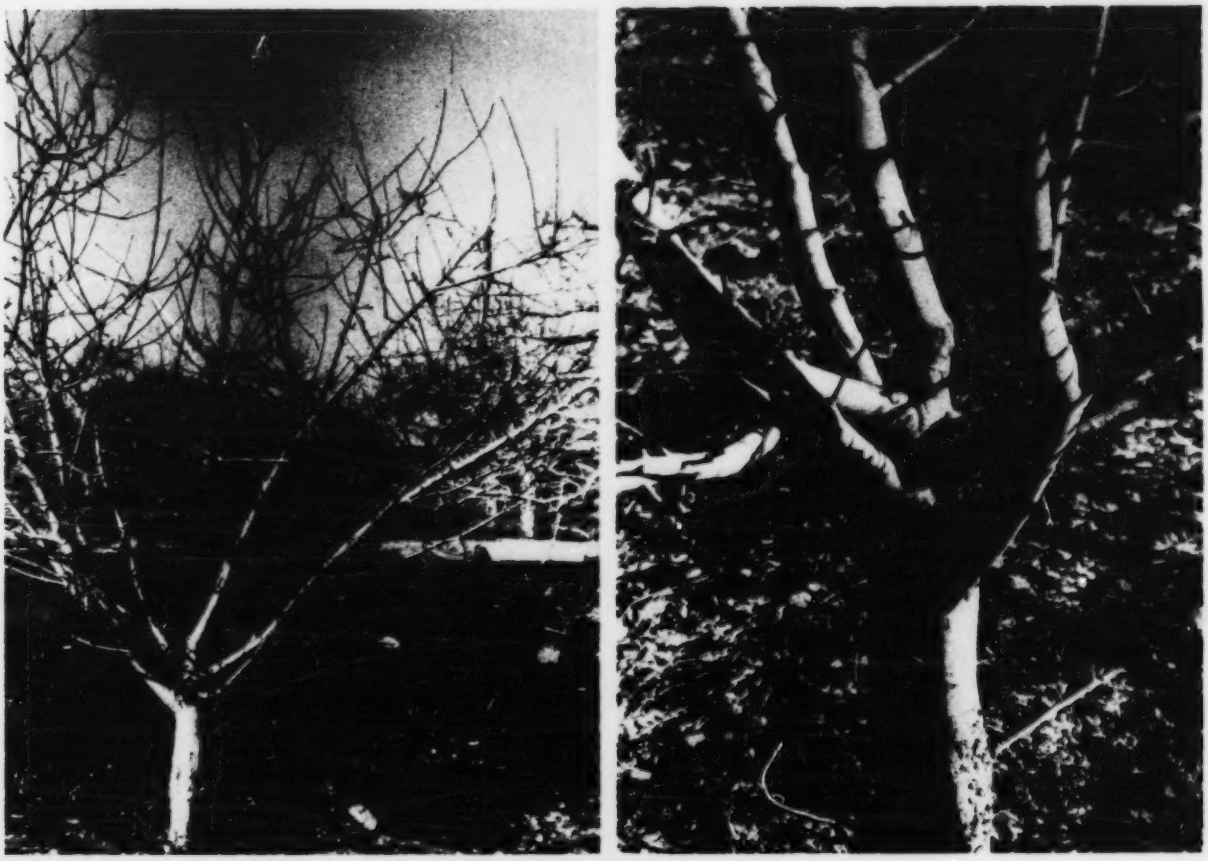


Figure 8. Loss of central leader dominance due to the interruption of the vascular connection to the leader by an excessive number of closely spaced scaffold limbs. A globular canopy shape results from loss of leader dominance.

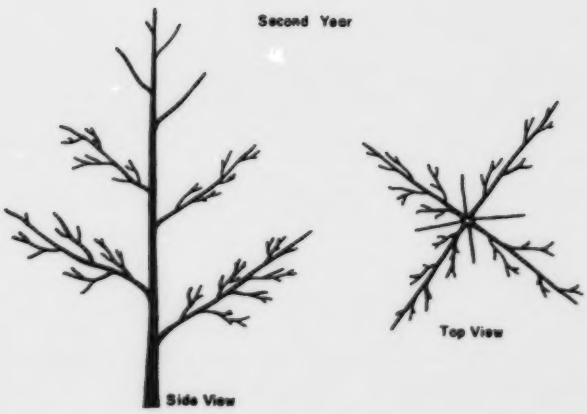


Figure 9. Selection of scaffold limbs in the second year in the orchard. Upper scaffolds should bisect quadrants occupied by lower scaffolds to avoid overlap.

Training and Pruning the Young Tree

A. Free-standing Trees

Year one (at planting)

Immediately after planting but while it is still fully dormant, the tree should be headed-back to stimulate vegetative growth and to bring the shoot into balance with the root system. For a normal one-year whip, heading height should be between 75–90 cm (30–35 inches). All lateral shoots should be removed, unless there are at least three well-formed laterals with wide crotch angles of approximately equal size, properly positioned along the trunk to become effective scaffold limbs. Two-year-old or well-feathered trees should be headed-back to a vegetative bud to stimulate growth. On such trees, any shoots not intended for scaffold limbs should be removed. Any lateral shoots which are considerably larger than the rest

should either be removed completely or headed-back to bring them into balance with the others.

Once shoot growth has begun, a single central leader should be selected as previously described (page 11). All shoots less than 45 cm (18 inches) from the ground should be removed. Some shoots with potential to be scaffold limbs will emerge with narrow-crotch angles. This condition can be corrected by using round toothpicks or clothes pins to widen the crotch angle. If any flowers are present, they should be removed as soon as possible. No further pruning should be carried out during this first growing season.

Year two

During the dormant pruning season, the central leader should be headed-back by one-quarter to one-third to stimulate continued strong vegetative growth (Figure 10). Scaffold limbs in the first tier should be selected according to previously described criteria (Page 14, Figure 10). Lateral shoots with narrow crotch angles or other characteristics undesirable for the permanent canopy structure should be removed. The heading-back of scaffold limbs is not generally recommended in non-fruiting trees. With cultivars such as 'Idared', terminal flower buds are common and may be removed during pruning. In cultivars with upright growth, such as 'Delicious,' scaffold limbs should be spread to 45–60° from the vertical position (Figure 10). Care should be taken not to position scaffold limbs near or below the horizontal.

With many cultivars, flowers may form on the leader and new scaffold limbs; these must be removed to prevent excessive early fruiting. Flowers or fruitlets can be removed by hand or by chemical means. If chemical removal is used, trees should be carefully examined afterwards and any remaining fruits removed by hand.

Year three

Maintenance of a dominant central leader should be carried out by repeating the same leader management process described previously (page 11, and Figure 11). Additional scaffold limbs should be chosen following the same criteria as described on page 11. As far as possible, limbs should be chosen which do not overlap those below and are separated from the first tier by at least 20 cm (8 inches) (Figure 11).

Where tree growth has been exceptional, limited fruiting may be allowed in the third season. However, early fruiting should be carefully controlled to avoid serious weakening of vegetative growth. Fruiting should be allowed only on those scaffold limbs physically capable of carrying fruit. No fruiting should be permitted in the upper parts of the tree or on the leader. If the tree is not large enough to carry a crop sufficient in size to pay for the additional spray and harvest costs, the entire crop should be removed and vegetative growth should be permitted to continue without interference.

Year four and later

Central leader and scaffold limb management should be continued as described previously until final tree height is achieved (pages 11 to 13). By the fourth season, most young trees are ready to carry a small crop of fruit. Again, fruiting must be controlled so that continued vegetative growth is not jeopardized. Careful crop load adjustment, probably necessitating some hand thinning, is essential. As cropping levels increase, extension growth of the lower scaffolds may diminish. If this condition develops before the lower scaffold limbs have filled their assigned spaces, heading-back of the terminal extension shoot on each limb may be required to maintain adequate vegetative growth. A combination of appropriate thinning-out and judicious use of heading-back cuts when required should assure continued vegetative development. Note that upper scaffolds should not be allowed to extend beyond the lower limbs. Attention to these details will result in development of an effective canopy structure (Figure 12).

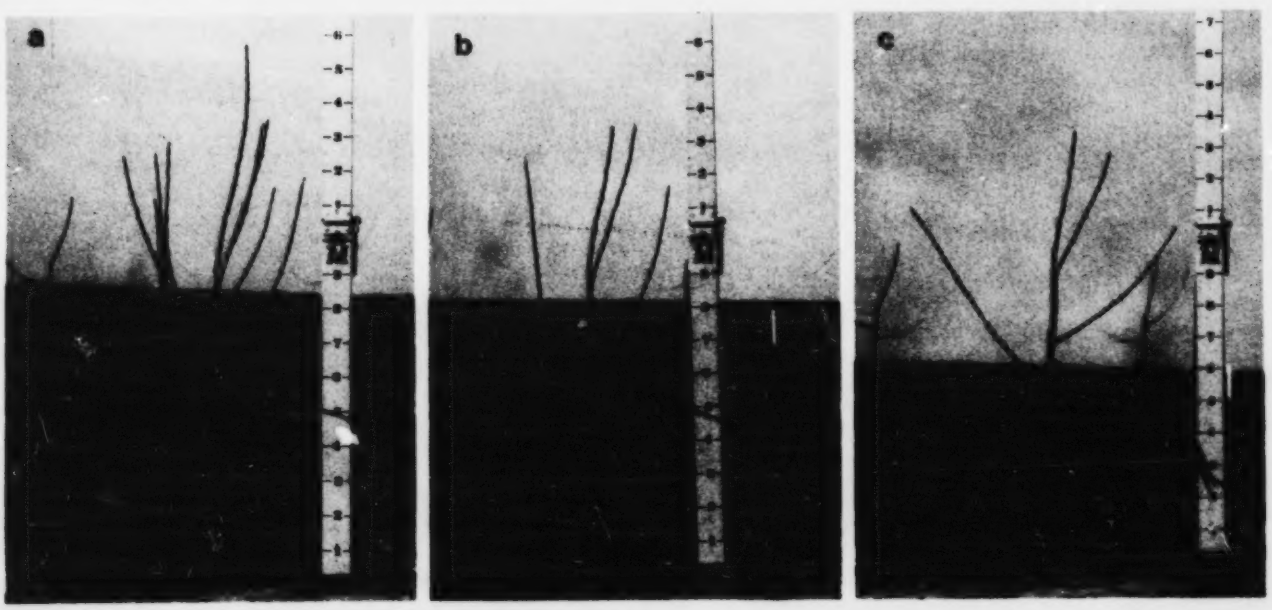


Figure 10. One-year-old 'Redspur Delicious' /MM.106 tree in early spring of the second year in the orchard (a), showing heading-back of central leader and selection of scaffold limbs (b), and limb positioning (c).

Figure 11. Pruning and scaffold limb selection in two-year-old 'Empire' /M.26 trees.

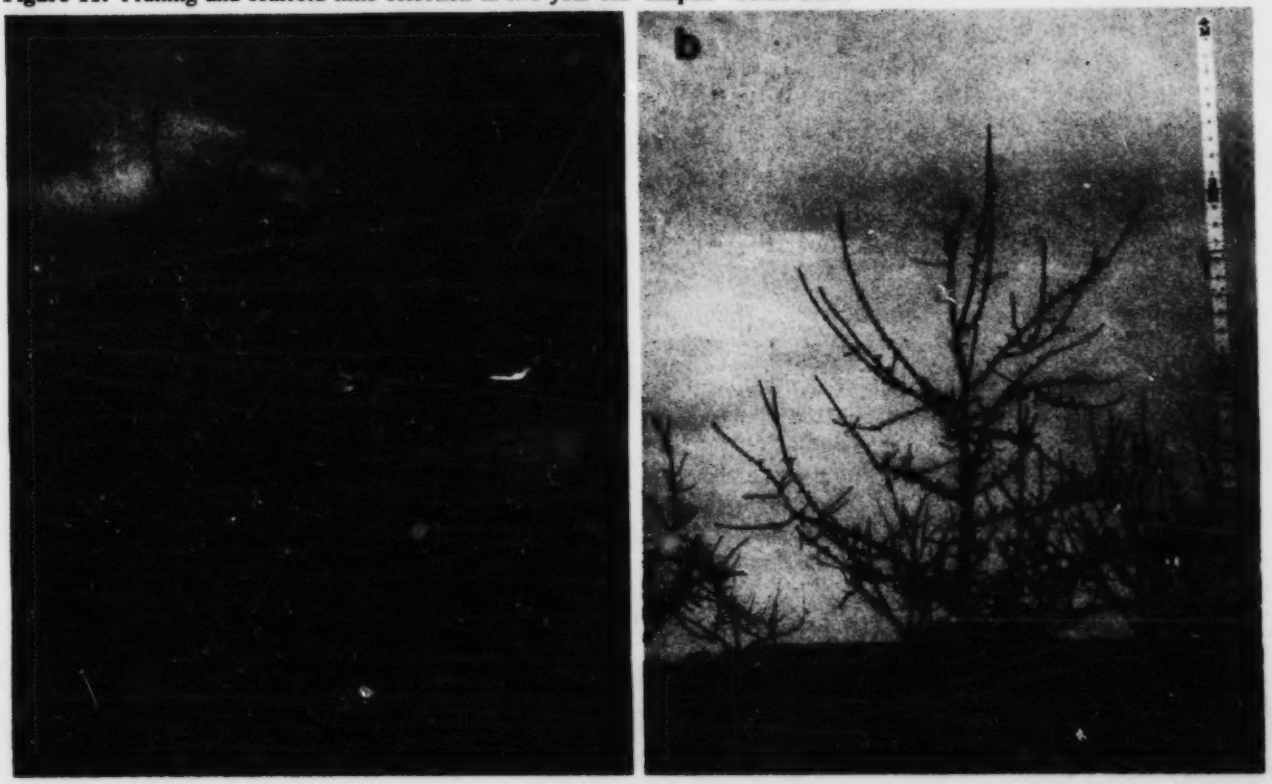


Figure 12. Results of good training and pruning practices are illustrated by five-year-old 'Idared' (a) and 'Empire' (b) trees on M.26 rootstock.

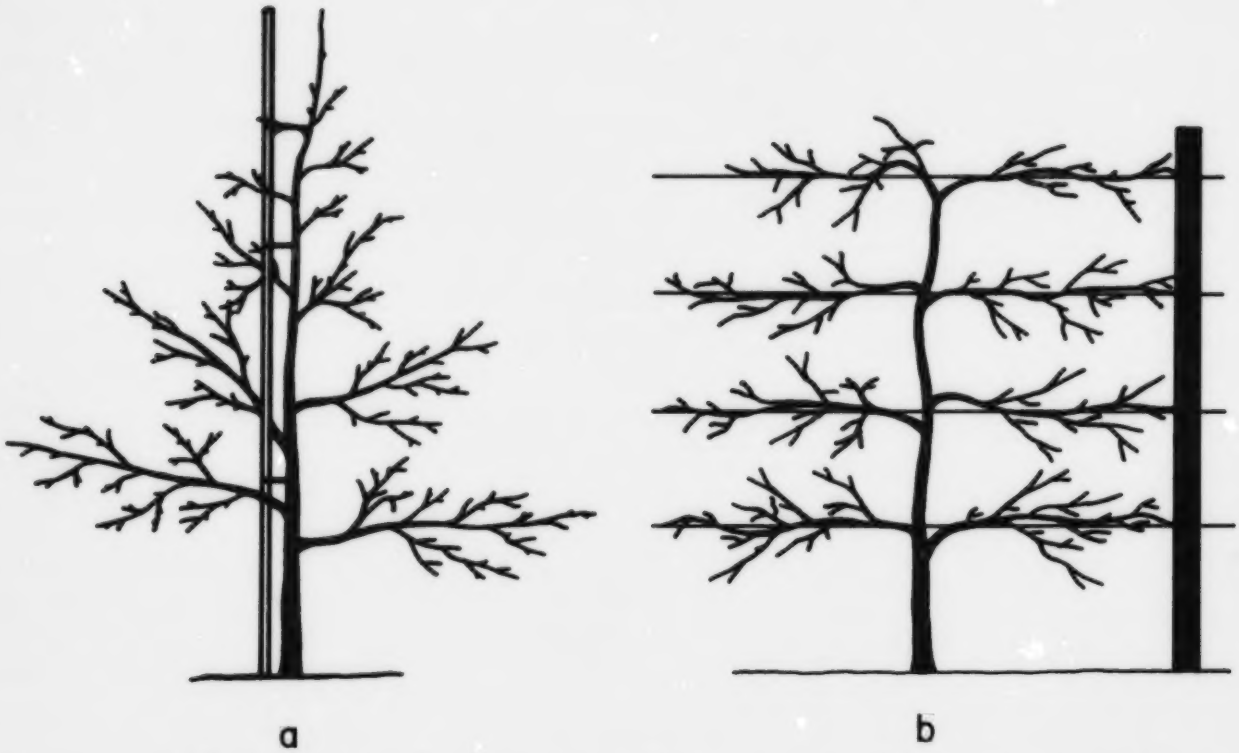


Figure 13. Trees may be supported by an individual pole (a) or trellis system (b). Many variations in tree shape and support structure are possible.

B. Supported Trees

Trees supported temporarily but intended to be free-standing or those supported only by a trunk stake should be trained according to the same principles described previously for free-standing trees. Fully supported trees are normally planted at high densities. Full tree support permits considerable variation in canopy shape, which is limited primarily by the nature of the support system employed (Figure 13). For this reason, training and pruning practices for supported trees may vary substantially from those applied to free-standing trees.

A dominant central leader is less important in a supported tree. In such cases, support is provided by the pole or trellis. Since a strong central leader is not necessary, heading-back the leader should be avoided. Where leader growth is excessive, the leader shoot may be removed and a weaker lateral left unpruned and trained in its place. This helps control the vigor of the upper part of a supported tree.

In high-density orchards, the amount of vegetative growth must be closely controlled. It is very important to select and position scaffold limbs to enhance early fruiting on the tree. Scaffold limb selection should be based primarily on the distribution of limbs around the tree or position on the leader relative to the trellis support wires. The vertical distance between scaffolds is less important since the canopy will be small, but an open structure should still be maintained. Normally upright cultivars require considerable limb positioning or tying to the trellis to achieve heavy early fruiting. The emphasis in high-density plantings should be on the stimulation of early fruiting to control vegetative vigor. Heading-back cuts should be avoided. Any unnecessary stimulation of vegetative growth can quickly lead to crowding and excessive shading within the canopy.

Pruning Mature Trees

A. Goals

As the tree matures, the management program shifts from framework building towards four main goals: (1) maintenance of canopy structure and shape to achieve uniform light distribution throughout the canopy; (2) maintenance of uniform vigor in the upper and lower parts of the tree; (3) renewal of the bearing wood to maintain a healthy, productive spur system; and (4) elimination of crowding between adjacent trees in dense plantings. Accomplishment of these goals requires, in addition to proper pruning, careful attention to fertilization, irrigation, thinning, pest control and other cultural practices. These orchard practices will insure a healthy leaf surface and a balance between cropping and vegetative growth.

Many small pruning cuts produce a greater response in vegetative vigor than a few large cuts. In pruning mature trees this concept can be combined with those described in previous sections to help regulate vigor within the tree.

B. Timing

In most circumstances pruning of mature trees should be confined to the dormant period and, where possible, delayed

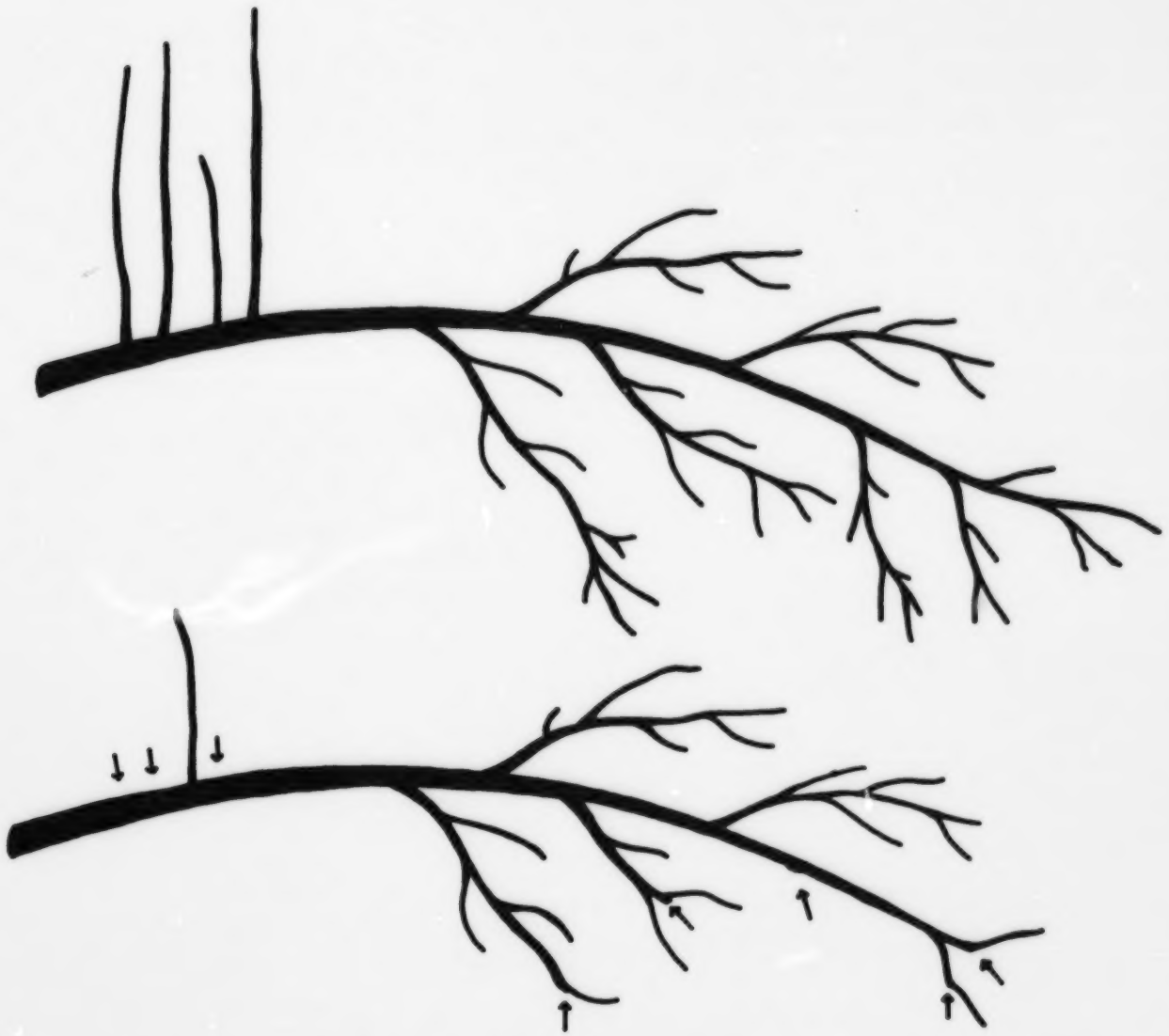


Figure 14. Removal of excessively vigorous growth and shaded, weaker, downward-oriented wood in mature trees (arrows mark points of cuts).

until after the coldest part of the winter has passed. This permits trees to achieve maximum hardiness prior to pruning and reduces the risk of exposure of pruning cuts to severe cold. Very vigorous trees or those requiring several very large cuts should be pruned later in the season to reduce risk of injury due to the freezing.

Since summer pruning results in the removal of active leaves, it may have a depressing effect on vigor. Summer pruning should be applied only in specific circumstances, which will be described later (page 18).

C. Control of Vegetative Vigor

A certain amount of shoot growth must be maintained in the canopy of a mature tree to insure good fruit size and provide new growth for renewal of bearing wood removed by pruning. Maintenance of uniform vigor throughout the canopy is only possible if light distribution is also nearly uniform. Development of excessive vigor in the tops of trees can lead to increased shading of the lower canopy. Excessively vigorous wood should be removed completely (Figure 14). Drooping branches which exhibit poor growth may also shade the interior of the canopy; fruits from these branches are often undersized and of poor color. Consequently, drooping wood should be thinned to remove the weakest and most poorly exposed sections (Figure 14), and help improve light exposure in the interior of the canopy.

Neglected or poorly managed trees may become spur-bound, exhibiting little or no shoot growth. This condition develops readily in older 'Idared' and spur-type 'Delicious' trees, although it can occur in any tree allowed to become very low in vigor. Fruit size suffers and renewal of bearing wood

becomes virtually impossible under such conditions. Old, multi-branched spur systems should be thinned to a few buds, some spurs removed and others headed-back to reduce the number of growing points. Removal of approximately 30% of the buds will stimulate renewed vegetative growth. Some adjustment in the fertilization program may be necessary for trees pruned in this manner. However, fertilizer alone will not correct a spur-bound condition.

D. Crowding

In high density plantings, serious problems of overcrowding can develop at any time, resulting in excessive shading. The loss of vigor and fruitfulness in the lower part of the canopy may be followed by a corresponding increase in vigor and growth in the tops, which exacerbates the problem. Careful control of vegetative growth by fruiting, soil management and pruning is necessary to avoid this problem.

Where crowding creates a problem, the pruning program should be designed to control, rather than stimulate, vegetative growth. Therefore, it would be preferable to remove entire limbs with a few large cuts, rather than to stub each undesirable shoot. Only thinning-out cuts should be used to avoid stimulation of vegetative growth. Because of the limited tolerance for growth between trees in dense plantings, any stimulation of vegetative growth is likely to rapidly restore the previous crowding condition.

A substantial effort may be required to restore a suitably productive canopy for old or neglected trees. Depending on the initial condition of the trees, this process may take several years. A careful analysis of the economic merit of the renewal program should be carried out prior to initiation of renovation. In some cases, removal of the orchard may be preferable to the expense and effort required to correct the situation.

Summer Pruning

Since summer pruning removes active leaf area, tree vigor will be reduced. For this reason, summer pruning should be confined only to trees which exhibit excessive vegetative vigor. Trees of moderate or low vigor may be seriously weakened if a significant portion of the active leaf area is removed. Pruning from bloom to late July is much more likely to reduce overall vigor and induce renewed shoot growth than later pruning. Early-season summer pruning may also inhibit flower-bud formation.

Summer pruning should be limited to two major objectives: (1) control of vegetative vigor by selective removal of excessively vigorous growth; (2) improvement of fruit color where excessive vegetative growth causes heavy shading in the canopy. Summer pruning is not a substitute for dormant pruning. Summer cuts should be limited to removal of the current season's growth. Repeated summer-pruning cuts into older wood over several seasons will dramatically reduce the amount of fruiting wood. Consequently, all structural pruning should be left until the dormant period.

Summer pruning should be delayed until terminal buds have formed and shoot growth has ceased. This will prevent regrowth on summer-pruned shoots. However, it should not be postponed until fall when trees are undergoing hardening for the winter period. The optimum time for summer pruning is in late July or August. At this time, summer pruning, unless heavy, will produce little or no regrowth. Removal of vigorous shoots and their shade will improve fruit color development without significant interference with the hardening process.

Mechanical Pruning

This type of pruning is attractive because of the savings in pruning costs. Unfortunately, experience with mechanically pruned trees has shown that the need for dormant pruning may actually increase, thus increasing pruning costs rather than lowering them.

Various types of equipment have been used to mechanically prune apple trees, from simple cutter bars to complex saws capable of very large cuts. The major drawback to all mechanical pruning of apple trees is its lack of selectivity. Mechanical pruning stubs back all branches, regardless of size. This approach can often produce an enormous vegetative-growth response, resulting in heavy shading and all the negative consequences which result from it. Follow-up hand pruning is an absolute necessity after mechanical pruning to thin out and remove vigorous wood and restore some balance to the canopy. Even with this additional effort, mechanical pruning should be approached with considerable caution.

Using a cutter bar to shear the current season's shoots in late summer is a more easily managed approach. As with dormant mechanical pruning, however, some follow-up is necessary to eliminate undesirable stubs which will produce excessive growth the following season.

Air-or hydraulically-operated shears and saws can be used to partially mechanize conventional pruning. In skilled hands, this type of equipment can definitely improve pruning efficiency. However, because of the ease with which cuts can be made with this equipment, it is possible for unskilled pruners to do considerable damage in an orchard. If mechanized pruning aids are used, careful supervision of the pruning crew is essential.

Cherry

Sweet
&
Tart

G. Tehrani

TRAINING AND PRUNING CHERRY TREES (SWEET AND TART)

Introduction

In recent years, two major changes have taken place in the planting and harvesting process of tart cherries. Now tart cherry trees are planted at closer spacings and limb and trunk shakers are widely used for harvesting. General training and pruning methods employed especially in new orchard plantings must accommodate these new trends.

Sweet cherry trees naturally develop into large trees. By proper pruning, trees can be kept low and within a desirable, manageable size.

Physiological Aspects of Training and Pruning Cherry Trees

Unlike apple trees, relatively little specific information is available on the physiological responses of cherry trees to training and pruning practices. However, the main responses of apple (pages 7–8) to the effect of light, tree form and growth habit, will apply to cherry as well. Since cherry trees bear most of their fruit on short spurs, normally they require less pruning than apple trees. Also, fruit color development in apple is enhanced with direct exposure to sunlight; whereas cherries do not require such exposure for good fruit color development. As with apple trees, light is essential for photosynthesis, flower bud formation and productivity of cherry trees during the life of an orchard.

Training and Pruning Young Cherry Trees

Proper tree pruning at planting time is important for the training process during the second and third year of growth. At this stage, a proper framework is established for young trees without an unnecessary delay of the fruiting process. At planting time, all broken, ragged, withered or dead roots should be cut back to live, healthy tissue. This promotes quick healing of wounds and early development of branch roots.

When the trees are dug up in the nursery, a large percentage of the root system is cut. In order to re-establish a balance between top growth and the root system, trees should be headed-back at planting time. This will reduce water loss and set the stage for the training process. The height of the heading-back cut will depend on the training system to be used.

A. Tart Cherry

Based on recent work in Michigan, the **modified leader training system** is recommended for both tart cherry trees planted at closer spacings for hand harvesting and at wider spacing for mechanical harvesting.

The following procedures are suggested for training and pruning young non-bearing tart cherry trees:

Year one (at planting)

Only one-year whips with a trunk calibre of 15–18 mm (1/2–5/8 inch) should be purchased. Remove all lateral branches at planting time, but only head-back the leader when it is too long and slender (Figure 15). In such cases, cut the leader back slightly to a healthy, vegetative bud. In July, when new lateral shoots have grown to 8–12 cm (3–5 inches) in length, use rounded toothpicks or weighted or standard spring clothespins to force the new growth to a 90° angle from the vertical position (Figure 16).

Year two

Select four limbs with wide crotch angles which are equally well spaced in four quadrants around the trunk. No branch should be directly above another and branches should be at

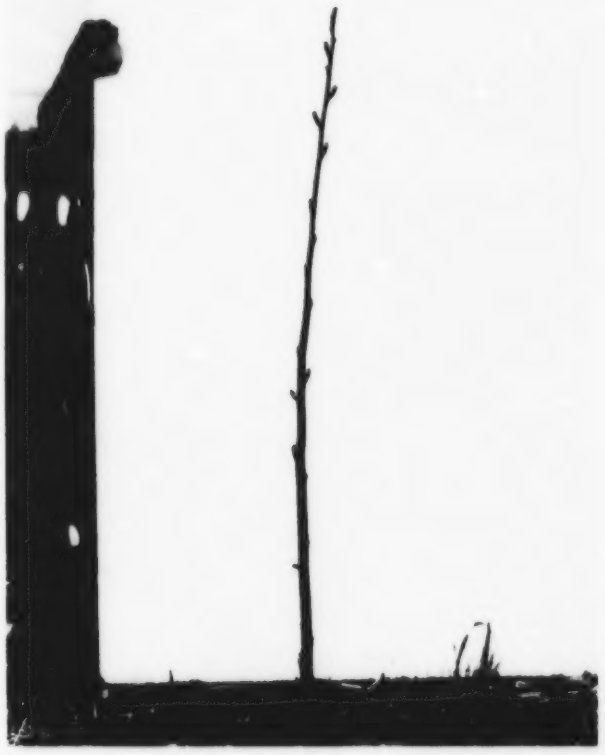


Figure 15. A newly planted tart cherry tree with all lateral limbs removed. Notice, the leader was not headed-back.

least 12 cm (5 inches) apart vertically. Leave a minimum distance of 75 cm (30 inches) between the lowest branch and the ground. Do not remove lateral limbs directly above the selected scaffolds; rather, cut these to stubs 10–15 cm (4–6 inches) long and remove them the following spring.

However, it is necessary to remove the highest lateral and any other scaffold branch which is too strong or equal in vigor to the central leader. If this is not done, these laterals will compete with and hinder the growth of the central leader. In some cases, where the required number of laterals cannot be selected, it would be better to remove all the lateral shoots and treat the tree as a one-year-old, selecting the desired scaffolds the following spring. If one or two well-positioned, properly oriented laterals are present, leave 1–1.5 cm (1/2–3/4 inch) stubs next to the leader (Figure 17). The buds on the sides of the stubs will grow new laterals with good crotch angles during the summer. If required, spread these new shoots with weighted or standard clothespins (Figure 16) as described under **Year one (at planting)**.

Year three

To start the second layer or tier of branches, select two to four more scaffold limbs, bringing the total number to six or eight. Again, cut the extra scaffold limbs directly above the selected ones to stubs 10–15 cm (4–6 inches) in length and remove them the following spring (Figure 18). Once again, remove other unwanted laterals and the ones competing with the central leader. The feathering growth between last year's branches and the newly selected laterals should be left for one or two more years to help balance tree growth. On last year's branches, thin out the upright or downward growing branches and leave only those which are parallel to the ground. Do not remove the terminal growth on branches in favor of an outward-growing lateral.

If the tree was headed-back as a one-year-old tree in the second spring after planting, choose six to eight scaffold limbs and stub the rest of the limbs located directly above or below the selected ones as described previously. When the required number of limbs is not available, choose whatever number are present and complete the selection of the scaffolds the following spring.

Year four and later

By this time, the tree should have six or eight scaffold limbs with good crotch angles. Thin the unwanted growth on last year's selected scaffolds. The central leader may not be very strong at this stage and could become the last of the scaffold limbs. At this time, remove all limbs which will prevent light penetration to the lower parts of the tree. This is essential to encourage productivity in the interior of the tree canopy.

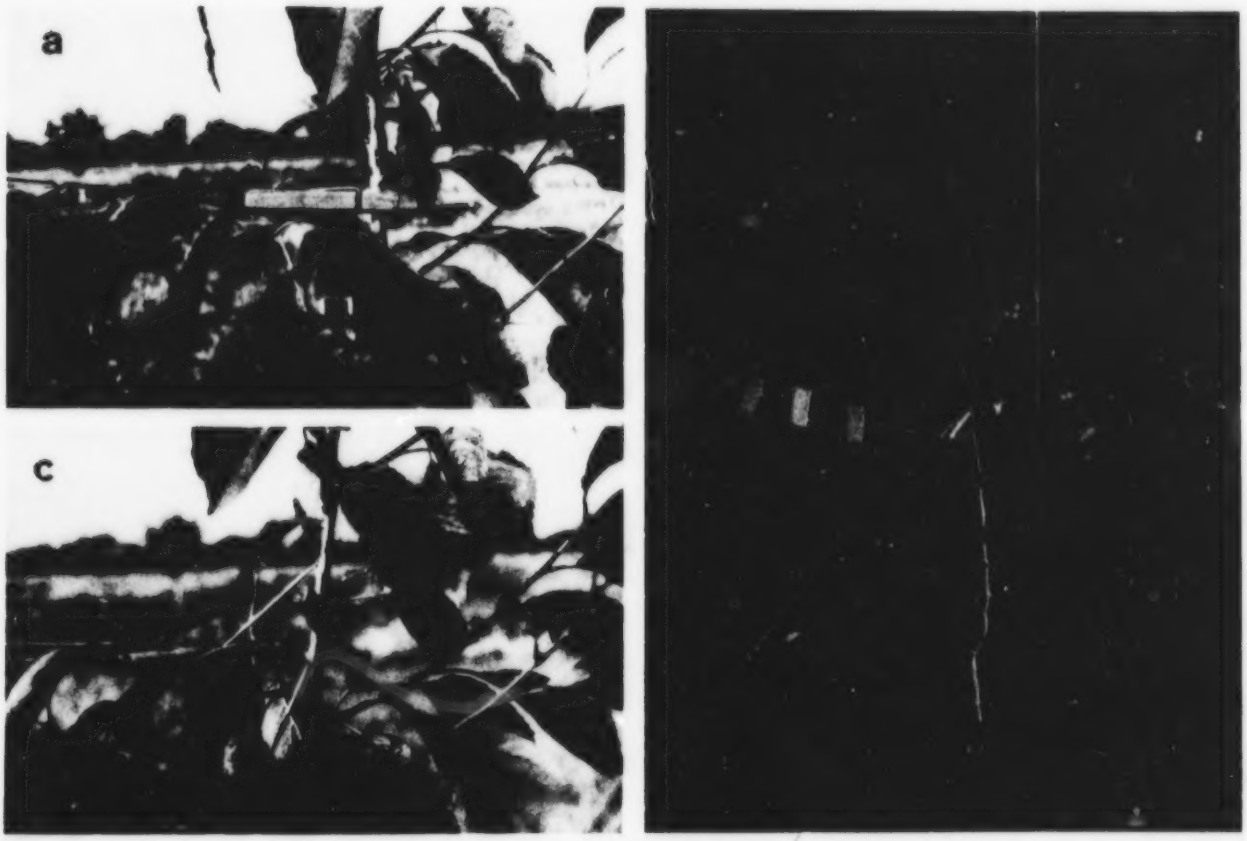


Figure 16. Placement of spring clothespin to force the new growth out at 90° angle from vertical position (a). Spring clothespin to spread the branch or weighted ones to bend it down (b). Round toothpick to spread crotch angles when new growth is 8–10 cm (3–5 inches) long (c).

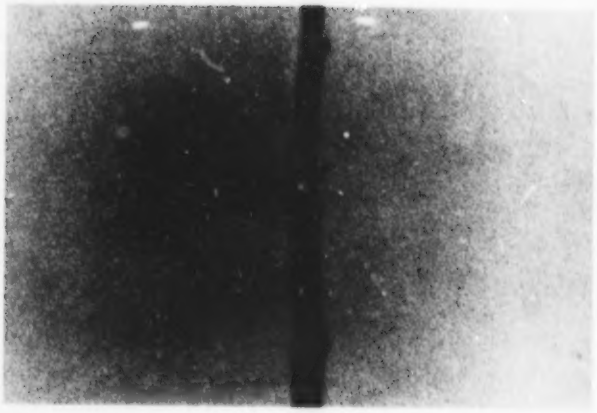


Figure 17. A tart cherry tree that developed only one or two laterals in year two should be treated as a one-year-old tree. Remove these two laterals and leave 1–1.5 cm (1/2—3/4 inch) stubs next to the leader. The buds on the sides of the stubs will produce new laterals with good crotch angles in the same position on the trunk.

B. Sweet Cherry

The **modified leader system** of training and pruning is recommended for sweet cherries. Only one-year old whips with a trunk calibre of 15–22 mm (1/2–3/4 inch) should be purchased. The following steps are suggested for training and pruning sweet cherry trees:

At planting

There are usually no wide-angled lateral branches on one-year-old trees at the height desirable for use. Therefore, remove all laterals at planting time (Figure 15). Then head-back the leader at about 36 cm (15 inches) above the height of the lowest scaffold to be selected the following year, or about one meter (40 inches) above the ground.

Year two

Select three to four scaffold limbs with wide-crotch angles spaced about 12–24 cm (5–10 inches) apart on the tree trunk (Figure 19). With sweet cherries even just two scaffold limbs will provide a satisfactory framework for the tree. Head-back the leader about 36 cm (15 inches) above the second layer or tier of scaffold branches that will be formed.

Year three

Repeat the selection of three to four more scaffold limbs in the same manner described above. In a sweet cherry tree with six or more scaffold limbs and the desired height, only head-back the leader slightly to the weakest side lateral (Figure 20). Cutting the leader to a weak side lateral will help in spreading the tree. The leader should be headed-back otherwise the tree will become tall and slender. Branches could also be headed-back to prevent upright growth of scaffolds. Otherwise, head-back the leader once more to about 36 cm (15 inches) above the next set of laterals to be established.

Year four

By this time, six to eight well spread scaffold limbs with wide-crotch angles should have been selected. If the leader was not headed-back the previous year, do so by cutting back to a weak-side lateral as described under **Year three** above.

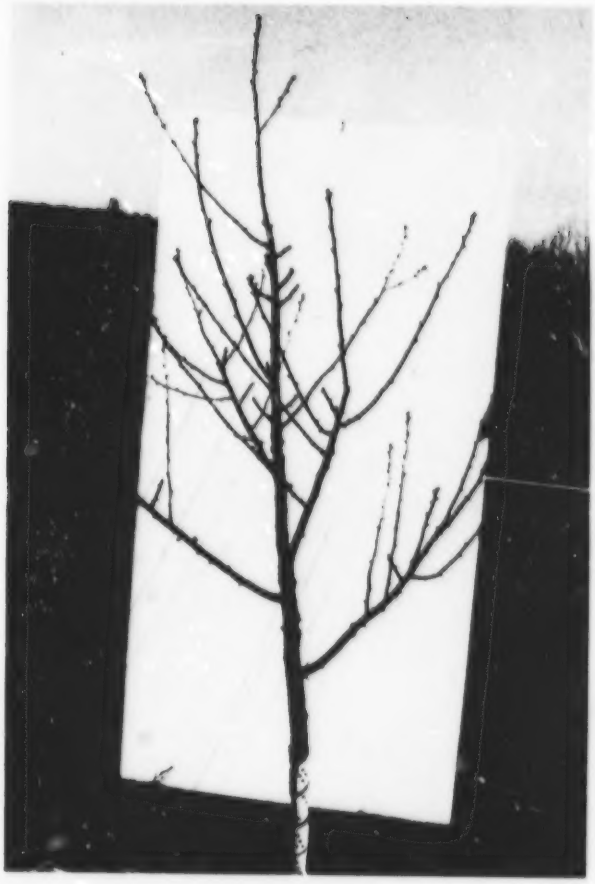


Figure 18. A well pruned and trained three-year-old tart cherry with seven scaffold limbs. Note the 10–15 cm (4–6 inches) long stubs left above the selected scaffold limbs. Remove these stubs the following spring.

Only the scaffold limbs which are parallel to the ground should be selected for use and the ones showing downward or upward growing eliminated.

Pruning Mature Trees

A. Tart Cherry

Tart cherry trees develop most of their fruit buds on shoots, short spurs and two- and three-year-old wood. Some fruit buds are borne on one-year-old wood; very few, however, are borne on wood over three-years-old. Each flower cluster has two to four flower buds. There are normally more flowers on low vigor trees than those exhibiting 30 cm (12 inches) or more annual growth. However, fruit will not size properly on low vigor trees and it is necessary for them to be stimulated.

Tart cherry trees require relatively heavier dormant pruning than sweet cherries to remove dead and weak wood, broken and crossover branches. If trees have not grown adequately, some branches must be thinned-out. Note that willowy branches are not desirable in tart cherry trees trained for mechanical

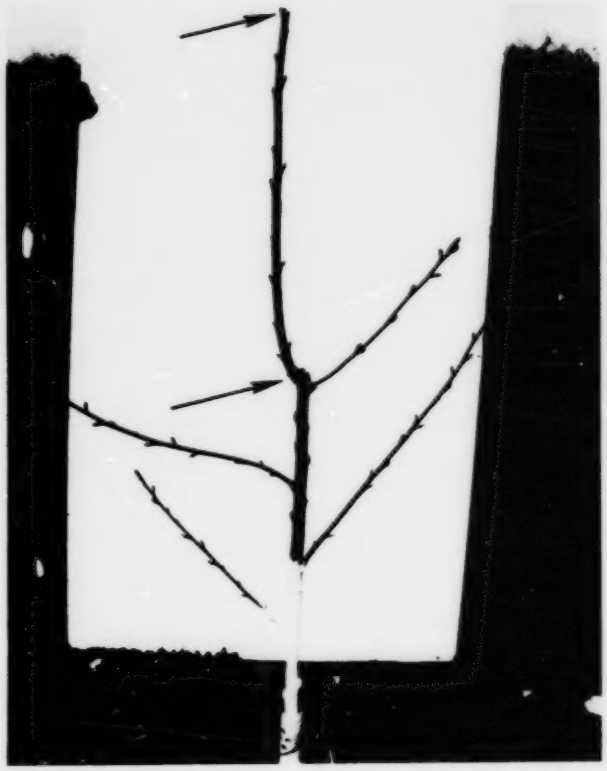


Figure 19. In the second year, select three to four scaffold limbs with wide-crotch angles spaced about 12–24 cm (5–10 inches) apart along the trunk. The arrows show where the tree was headed-back at planting time and in the second year.

shaking. To increase harvest efficiency, tart cherry trees must be pruned to promote the stiffness in the branches.

In some orchards, after several years of cropping, it will be beneficial to head-back the branches. This will induce new growth and should increase the orchard yield.

B. Sweet Cherry

Sweet cherry trees only require a very light annual pruning until they become too high for convenient management. In the early years, dead and weak wood, broken and crossing branches should be removed. Sweet cherry trees will grow relatively tall on Mazzard rootstock which is recommended for use in Ontario.

In order to reduce the tree size, head-back the large vertical branches. This will help the development of new fruiting wood and reduce the tree height. Rub off the suckers as they arise during the summer or remove them following spring with flush cuts using a sharp saw.

Summer Pruning and Shearing

A. Tart Cherry

Summer pruning has a retarding effect on tree growth. With

Figure 20. In a sweet cherry tree with six or more scaffold limbs and of the desired height, head-back the leader to a weakened side lateral to spread the tree top and reduce height.

young tart cherry trees it should be implemented with moderation only in certain locations on the tree. Removal of two to three very small laterals near the top of the central leader will help it achieve proper growth and development. Also, the pinching of overgrown scaffolds by 1–1.5 cm (1/2–3/4 inch) in midsummer will slow their growth for a short period of time.

In closely-planted tart cherry plantings trained to central leader, summer shearing has been used in the fourth year of growth. Normally, the shearing is performed six to seven weeks after full bloom. However, summer shearing **must** be followed up by dormant winter pruning to thin out the resulting dense growth. Otherwise, poor light penetration will prevent later flower-bud formation and result in decreased tree productivity.

B. Sweet Cherry

With sweet cherry, the pinching of young scaffolds during the growing season is an effective method of producing shorter trees. When the current season's shoots reach a length 54–60 cm (22–24 inches) in length, about 9–12 cm (4–5 inches) of the tip can be pinched out. Since all the branches will not reach the desired height at the same time, it may be necessary to repeat it two or three times during the first growing season. Pinching is practiced on trees where all the side branches on the whip were removed at the planting time. If lateral branches were left on one-year-old trees after planting, some side scaffolds will develop and no pinching should be practiced.

The pinching as described above will remove very little wood, and it will delay fruit bearing marginally. This delay in early fruiting makes pinching more advantageous than the dormant heading of branches. The main objective is to force a flush of branches below where the pinching was done. From these side branches, the second tier or layer of scaffold will be chosen the following spring.

If only tips of the branches rather than 9–12 cm (4–5 inches) of the growth is pinched, it may force branching at sharp undesirable angles.

Peach
&
Nectarine

N. W. Miles

TRAINING AND PRUNING PEACH AND NECTARINE TREES

Introduction

Peaches and nectarines are of the same species and have identical cultural practices, so both crops will be discussed as one topic.

Like other tree fruit crops, the objective for pruning and training peach trees is to develop and maintain a scaffold system that will enable efficient production of quality fruit. However, due to the innate characteristics of this crop such as the bearing habit, susceptibility to low temperature injury and the devastating effect of peach canker disease (Cytospora canker, Valsa canker) to the trees, some of the principles described in the introduction to this publication do not apply to peach training and pruning.

In peach, flower buds are initiated in the axis of the leaves of the current season's growth rather than on spurs. The flower buds overwinter and produce the fruit the following year on one-year-old twigs. Thus annual shoot growth is essential to sustain productivity. This means that peach trees require more pruning to assure adequate amounts of new growth each year than other fruit trees. Ontario peach orchard sites are on the northern fringes of the commercial peach production region. Tree growth is less vigorous here where the summers are cooler and shorter. This places even greater emphasis on cultural practices that maintain tree health and vigor.

Peach trees are inherently more susceptible to low temperature injury than other fruit tree species cultivated in Ontario. Extreme care must be taken by growers to minimize the possibility of winter damage. For example, a delicate balance must be struck between maintaining tree vigor and avoiding excessive growth that makes the tree more susceptible to low temperature injury.

Peach canker disease is the most serious problem limiting production of peaches in Ontario. There is no suitable control for this fungal disease caused by Leucostoma species. The severity of this disease is directly related to the pruning practices employed. To reduce the amount of canker infection, orchardists must employ training and pruning practices that limit these losses.

Peach canker and winter injury, which often are interrelated, are so important a consideration that Ontario orchardists always use pruning practices that limit peach canker and reduce winter injury. The combined effects of these two problems reduce the already short life of peach orchards to 10–15 years. Thus management emphasis is placed on early fruit production (beginning during the third year) from short-lived trees in closely spaced orchards. Strong, productive orchard trees result from planting good nursery stock, training properly at planting time and paying careful attention to early tree structural development.

Physiological Aspects of Training and Pruning Peach Trees

The main responses for peach relative to the effect of light on tree form and growth habit are the same as those described for apple (pages 7–8). Special considerations which make peach trees somewhat different than apples include: (a) the constant need for annual shoot growth to obtain new fruiting wood; (b) the importance of maintaining tree vigor throughout the life of the tree; and (c) the susceptibility of the plant to winter injury and canker disease. For a full discussion of peach canker disease, refer to OMAF Factsheet, *Peach Canker*, Agdex 212/634.

Peach canker disease causes deterioration and loss of twigs, branches, scaffold limbs and even the death of entire trees. The disease organism, a fungus, gains entry through open wounds such as leaf scars, mechanical injuries or pruning wounds. Possibly, as many as 25% of canker lesions result from pruning wounds. Moisture is required before the causal organism can infect fresh pruning wounds. Once infection has taken place, the organism causes an expanding necrotic area or canker which can girdle the twig or branch. Rapid healing of pruning wounds is important to avoid fungal penetration; this occurs more rapidly under warm temperatures. Approximately 390 accumulated degree-day units (base = 0°C), for example, are required for wound healing on the trunks of five-year-old 'Redhaven' trees. Wound healing means that several layers of protective cells have formed around the wound so that penetration of the fungal hyphae into susceptible tissues cannot occur. Complete enclosure of the wound by the newly formed protective layers of bark will occur much later. Wound healing is slower on trees weakened by winter injury. This partially explains the reason for more serious canker lesions after severe winters. Careless pruning weakens the tree, increases winter injury and delays normal healing of pruning wounds.

Trees with wide-crotch angles that are properly hardened for the winter survive best and are damaged least by canker. Any pruning that encourages late growth in the fall, narrow-crotch angles, or seriously reduces the canopy leaf area, preconditions the tree to winter injury and subsequent canker infection. Excessive cropping and internal shading could also predispose trees to canker infection.

Some special training and pruning considerations that will reduce winter injury and canker infections are presented below:

1. Peach pruning should be performed during the bloom period.

Most growers prefer not to prune peach trees until the flower buds have advanced sufficiently to assess the flower winter survival. Delaying pruning much beyond shuck split may cause a serious loss of tree vigor. Dormant pruning increases the risk of winter injury. Pruning during early spring should be avoided because the generally lower temperatures slow the wound-healing process. These unprotected wounds are more vulnerable to infection by the canker organism.

2. Prune when there is a warm, dry weather forecast.

Avoid pruning during or immediately prior to wet periods, since moisture is essential for the canker organism to infect pruning wounds. Also, water on the wounds slows the healing process.

3. **Avoid leaving pruning stubs likely to become infected with canker.**

Collar cuts are preferred over flush cuts which heal more slowly (Figure 21). The bark ridge where the smaller branch joins the scaffold should be retained because these tissues heal more rapidly, thus reducing the chance of canker infection.

4. **Open the tree canopy for light penetration into the interior of the tree.**

Shoot growth in the center of the tree will be stronger, more resistant to winter injury and less susceptible to canker infection if not subjected to crowding and/or shade.

5. **Remove dead twigs, especially those on major scaffold branches.**

Dead twigs become infected with the canker fungus, which can lead to the infection of major branches.

6. **Remove canker infections by cutting the branch at least 15 cm (6 inches) below the canker wherever possible.**

Cankers on trunks and large limbs can be surgically removed in late June or July when trees heal most rapidly. For further details, refer to OMAF Factsheet, *Peach Canker,* Agdex 2/2/634.

7. **Prune annually in order to avoid making major cuts.**

Large pruning wounds are more susceptible to canker. Remember that the removal of large branches reduces the total tree vigor yet may cause excessively vigorous water sprouts at the wound site.

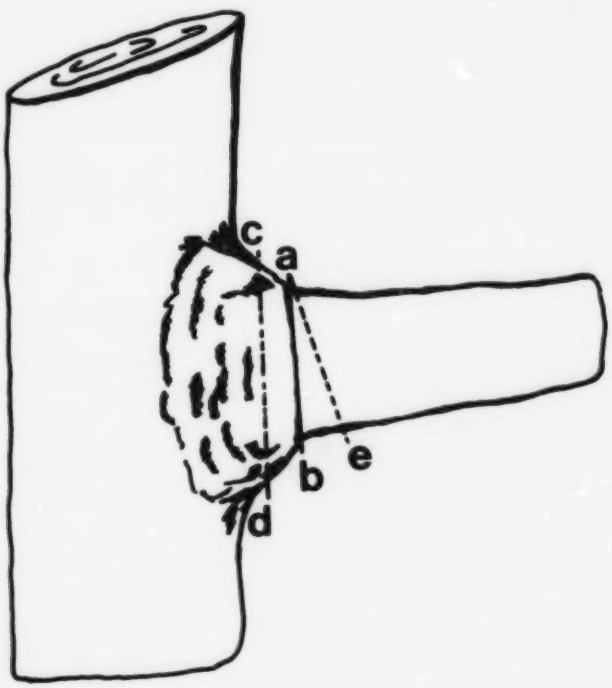


Figure 21. Collar cuts (line a-b) should be used rather than flush cuts (line c-d) or stub cuts (line a-e). Wood healing is more rapid when the bark ridges are not removed.

Principles of Training and Pruning Peach Trees

In recent years there has been a trend towards the establishment of peach orchards with closely spaced trees to obtain higher yields early in the life of the orchard. This has required training practices which promote the rapid establishment of the tree canopy for early fruit production while recognizing the need for labor efficiency.

Newly planted peach orchards must be established as quickly as possible to encourage fruit production during the third growing season. Peach trees grow slowly during the first season, but should be encouraged to develop several growing points from branches with wide-crotch angles. From these growing points, primary and secondary shoots rapidly provide a great potential for photosynthesis. In the following years, this promotes vigorous shoot growth, a sturdy tree structure and a strong root system with the accumulation of good starch reserves. By the third year, the established tree is capable of bearing a substantial fruit crop. Full production should be obtained by the fifth or sixth growing season. By the eleventh or twelfth year, peach trees start to deteriorate and production may decline.

A. Training and Pruning Systems

Peach trees in Ontario orchards are trained to either a **modified leader** or an **open center system**. The modified leader system allows the scaffold limbs to be spaced vertically along the trunk and symmetrically around the trunk in the four principal compass directions. The advantages of the modified leader system are earlier production, stronger trees, longer-lived trees and greater continuity of the orchard-bearing area. This training system is recommended for closely spaced orchards.

The open-center system develops a low spreading canopy, since the two to three scaffold limbs originate from approximately the same location on the trunk. This system allows a larger portion of the bearing-surface area to be exposed to stronger sunlight in the upper part of the tree. The open-center system is easier and faster to prune and preferred by some orchardists but it requires wider spacings between rows.

In recent years, attempts have been made to improve production efficiency through high-density planting systems. Some orchardists have planted double-tree rows and adapted the modified leader system to accommodate the higher tree density. Experimentally, hedgerows have also proven productive and profitable. Several other training systems are being tested around the world, such as the Tatura trellis, Lincoln canopy, Ebro, palmette, and central leader, but none can be recommended for use in Ontario orchards at this time. However, growers should be alert for improved training and trellising systems that, with modification, could be more profitable than current systems.

B. Pruning and Tree Productivity

Pruning affects tree vigor and productivity. Excessive pruning of a newly established orchards seriously delays fruiting. Thus, recommendations for training young trees stress the use of only corrective pruning cuts necessary to eliminate structural problems. Selective thinning-out of branches should

be delayed until fruit production has begun. The vigor of mature trees is influenced by pruning, mineral nutrition, productivity, irrigation and other cultural practices. Regulating productivity is extremely important, since overproduction seriously reduces tree vigor and the potential for cropping and may shorten tree life. Selective pruning to reduce the amount of bearing wood is the first step towards controlling productivity. This must be followed by proper fruit thinning. Excessive pruning, fertility and thinning will result in highly vigorous trees and poorly colored, low-quality fruit. In addition, pruning during the following years is laborious and difficult.

C. Painting Wounds

There are conflicting opinions regarding the use of wound paints and sealers. Some evidence suggests they are cosmetic and, unless combined with a fungicide, do little to prevent canker infection or other structural decay. Materials that seal the wounds provide an ideal environment below the seal for fungal development. The practice of covering wounds with thiram-latex paint mixture may provide some degree of protection against canker fungal infection. These paints should not contain acrylic resins that injure living plant tissue. Note, however, that the practice of painting tree trunks with white thiram-latex paint continues to be recommended to reduce rodent damage and winter injury. For full details, refer to OMAF Publication 360, *Fruit Production Recommendations*.

Training and Pruning Young Peach Trees

The recommended procedures for training a peach tree to the **modified leader** will be described.

Ideally 4–6 scaffold limbs should be spaced 20–30 cm (8–12 inches) apart along the central axis (trunk) in the four

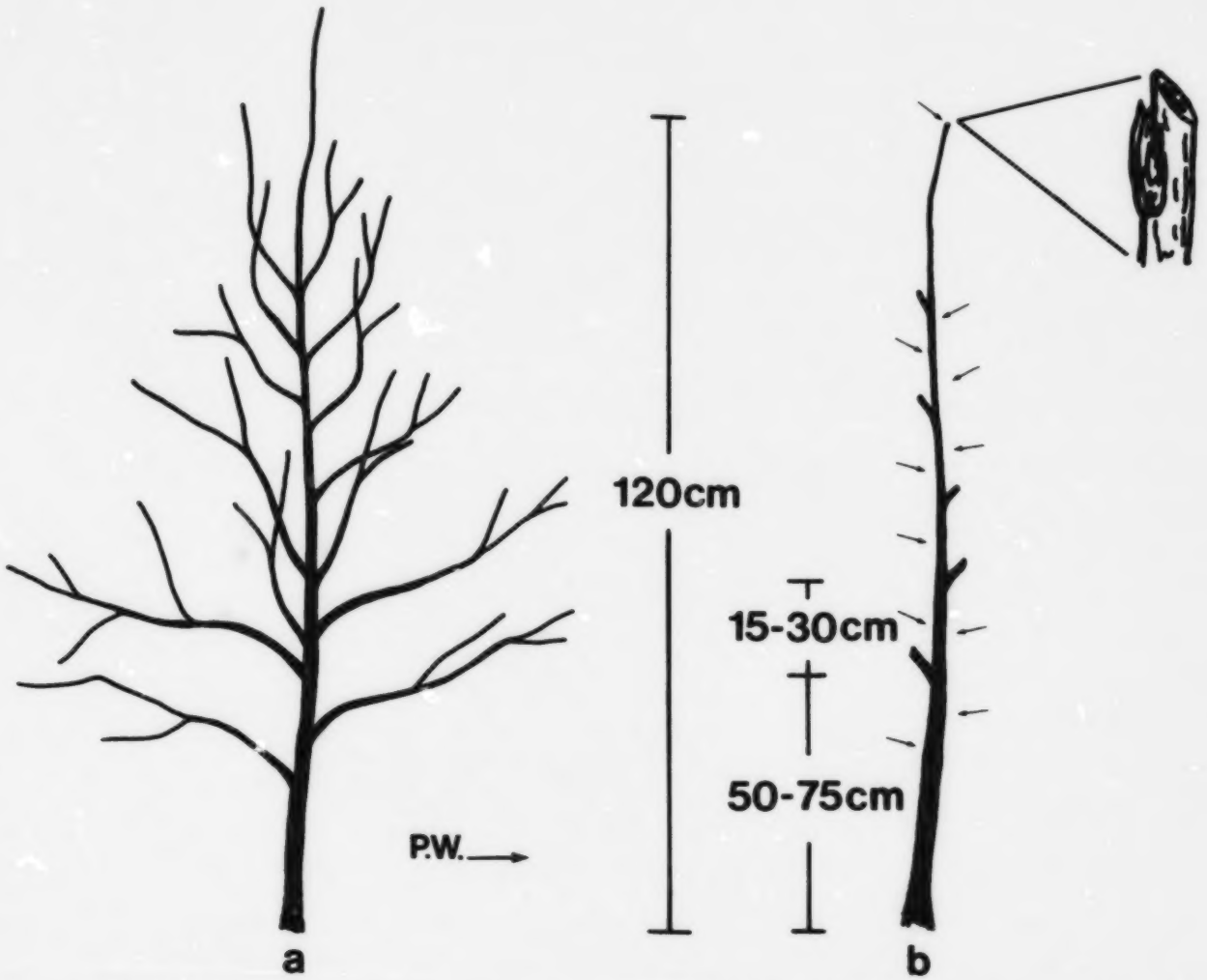


Figure 22. A well feathered one-year-old nursery tree before (a) and after (b) initial training to achieve a modified leader tree. The arrows indicate where pruning cuts were made and the direction of the prevailing wind (P.W.) is indicated.

compass directions. Crotch angles should be 60–70° from the vertical position and the diameter of selected scaffold limbs should not exceed that of the main trunk. Trees should be pruned sparingly but accurately during years one to three when the scaffold limbs are selected. During this period, undesirable branches should be eliminated, but the maximum number of growing points retained. Once an adequate bearing volume is established, it is necessary to selectively remove competing scaffold limbs to allow light penetration into the interior canopy and to avoid an excessive fruit load.

Year one (at planting)

Pruning at planting time is important to assure good tree establishment in the orchard and provide an opportunity for good, strong tree structure with maximum fruit production potential (Figure 22). Remove all lateral branches below 50–75 cm (20–30 inches) in height, all dead or broken stubs and all branches with narrow crotch angles that will compete with the leader. Collar cuts should be used (see Figure 21). Cut back the remaining branches to two healthy buds. A maximum of 6–8 well spaced branches should be retained. It may be necessary to remove some additional branches from well feathered nursery trees by using collar cuts. Top the leader at 1.2 m (48 inches) in height for strong nursery trees, but at a lower height for less vigorous trees. Be sure to leave a strong terminal bud oriented into the direction of the prevailing wind. Prune trees soon after planting when weather is sunny and dry and likely to remain so for a few days. This condition is less conducive to canker infection.

First summer

Summer pruning should be kept to a minimum. Some pruning is necessary since it will help reduce the wood to be removed the following year. Inspect the trees within two months after planting, when rapid growth is taking place. Pinch or rub off shoots on the trunk below the lowest scaffold limb as well as obviously poor shoots which compete with the leader or selected scaffolds. Dead stubs should also be removed at this time, using collar cuts to avoid aggravating canker infections.

Year two (after the first dormancy)

Training should be done during late spring to coincide with the bloom period of mature trees. Prune during dry periods and use collar cuts to minimize canker infections. Remove poor branches such as:

1. competing leaders;
2. narrow angled upright growth;
3. upright and inward shoots arising from scaffold limbs;
4. secondary branches on scaffolds that are too close (8–10 cm or 3–4 inches) to the main trunk;
5. new growth appearing below the lowest selected scaffold limb; and
6. branches and twigs infected with the canker organism.

Start at the top of the tree and work towards the base. Some scaffold limb thinning may be necessary, especially if there is excess growth in the upper portion of the tree. Avoid heading-back cuts except to remove oriental fruit moth strikes or winter die-back. Flower buds will be present on one-year-old wood, but defruiting the trees is recommended to en-

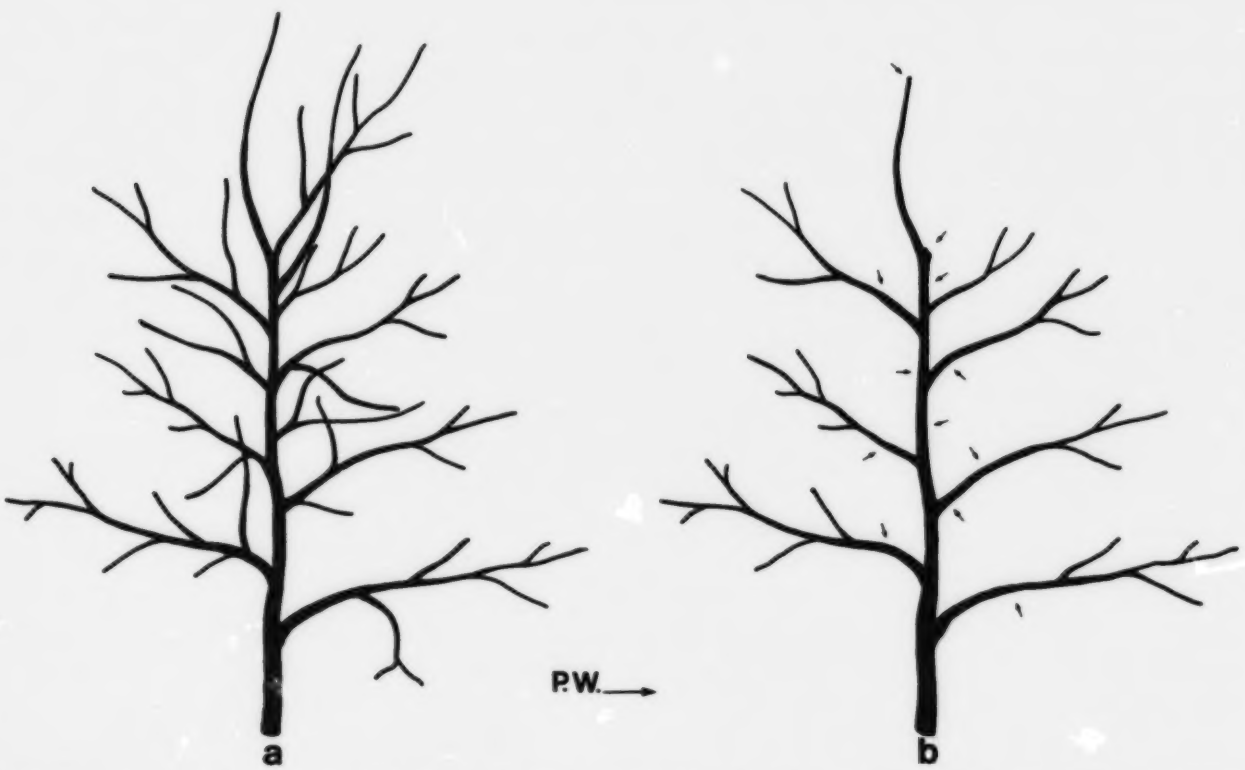


Figure 23. A dormant peach tree after two year's growth in the orchard (a) and after training during late spring (b). Arrows indicate where pruning cuts were made and the direction of the prevailing wind (P.W.) is indicated.

courage vegetative growth in year two. It may be necessary to select a new leader if the one chosen during the first year is displaced too far from the central axis by the wind.

Year three

In the third year well-grown trees will bear their first crop but do not allow the trees to overproduce. Pruning at this time will promote good light penetration into the canopy. The following pruning cuts are emphasized (Figure 23):

1. weak branches in the interior of the tree;
2. branches with narrow-crotch angles, especially those competing with the leader;
3. shoots growing upwards and inwards from the selected scaffold limbs;
4. upper scaffold limbs that are stronger than the leader.

Additional thinning-out cuts may be necessary to space secondary branches and reduce the amount of fruiting wood. Do not make heading-back cuts. Select a new leader to replace the original leader if it has been displaced by wind or been severely injured by canker infection or winter injury.

Year four and later

The trees are now approaching full production but their canopy volume is still enlarging. Efforts to space scaffold limbs along the central trunk should begin. Select four to six scaffold limbs with the strength and vigor necessary to support the weight of heavy crops, yet will give the tree good symmetry. Where two scaffold limbs occupy the same space, retain the stronger, better oriented and more fruitful of the two. Remove the competing scaffold limb using a collar cut at the trunk. Scaffold training is needed to space secondary branches and eliminate competing wood. Some minor heading-back cuts (Figure 24) may be useful to restrict the height and spread of the more vigorous scaffold limbs. Heading back the leader to a less vigorous lateral branch will restrict tree height. Light penetration within the canopy is important at this stage to keep the growth within the interior of the tree strong. Excessive shading causes weak wood which is less fruitful and more susceptible to winter injury and canker. Again, wood infected with the canker disease should be removed by making a cut at least 15 cm (6 inches) below the area of infection or by surgery during the summer.

Continue these practices for the following year or two as the tree develops a full canopy, entering its peak productivity when the scaffold system becomes fully developed.

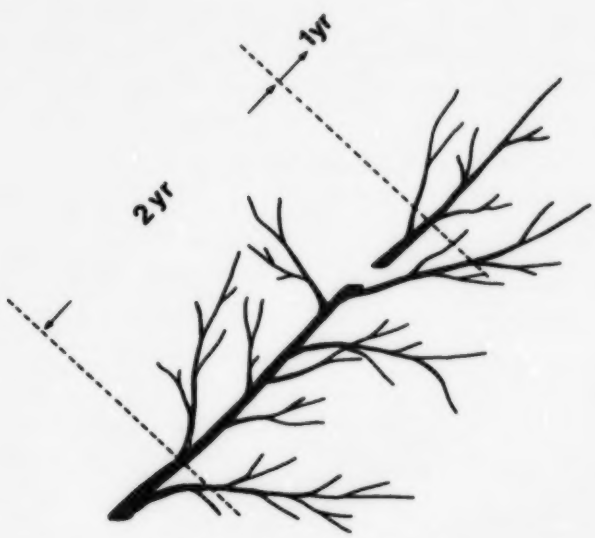


Figure 24. When heading-back cuts into the two-year-old wood are used, they should be made to a less vigorous side branch of three-year-old or older trees. This may be necessary to reduce the height or spread of vigorous trees that are too large for the allotted space.

Pruning Mature Trees

Pruning in mature trees is a valuable means of adjusting fruit production, regulating tree size and vigor, maintaining continuous productivity and tree health, and opening the tree canopy to light. Peach trees must produce moderately strong shoot growth to be productive the following year. Shoots 30–50 cm (12–20 inches) in length and pencil thickness are the most desirable and fruitful. Overly vigorous shoots are not fruitful, while weak ones are susceptible to winter injury and canker. Proper tree vigor should be maintained through pruning, fruit thinning, mineral nutrition, irrigation, pest management, and other orchard management practices.

The basic pruning required annually is the removal of dead or broken branches; branches weakened by canker or other diseases, winter injury, or insects; low drooping branches; vigorous upright growth and watersprouts. Additional pruning will depend on the crop potential as judged by the amount of good fruit-producing wood remaining on the tree and the number of flower buds that survived the winter. An additional consideration is the openness of the canopy and the height and spread of the tree.

Tree height must be restricted to allow efficient hand operations such as pruning, fruit thinning and harvesting. Tree spread must be restricted in closely-spaced orchards to avoid crowding within the rows and allow space for orchard equipment between the rows. This can be accomplished in part by proper **heading-back cuts** (Figure 24). A branch should be headed-back to a less vigorous lateral oriented in the desired direction. Bench cuts and stubbing-back cuts should be avoided.

Thinning-out cuts (Figure 25) are used to reduce the canopy density and, to a lesser extent, to reduce excessive fruit load. It may be necessary to remove some competing scaffold branches or secondary branches with collar cuts. Further thinning out of smaller branches and twigs on the scaffolds may be desirable. Branches of intermediate vigor and oriented horizontally are favored while weak downward or strong upward branches should be removed. Ideally the finished tree should have a uniform distribution of branches throughout an open canopy; however, economics will dictate the amount of detailed pruning that can be performed.

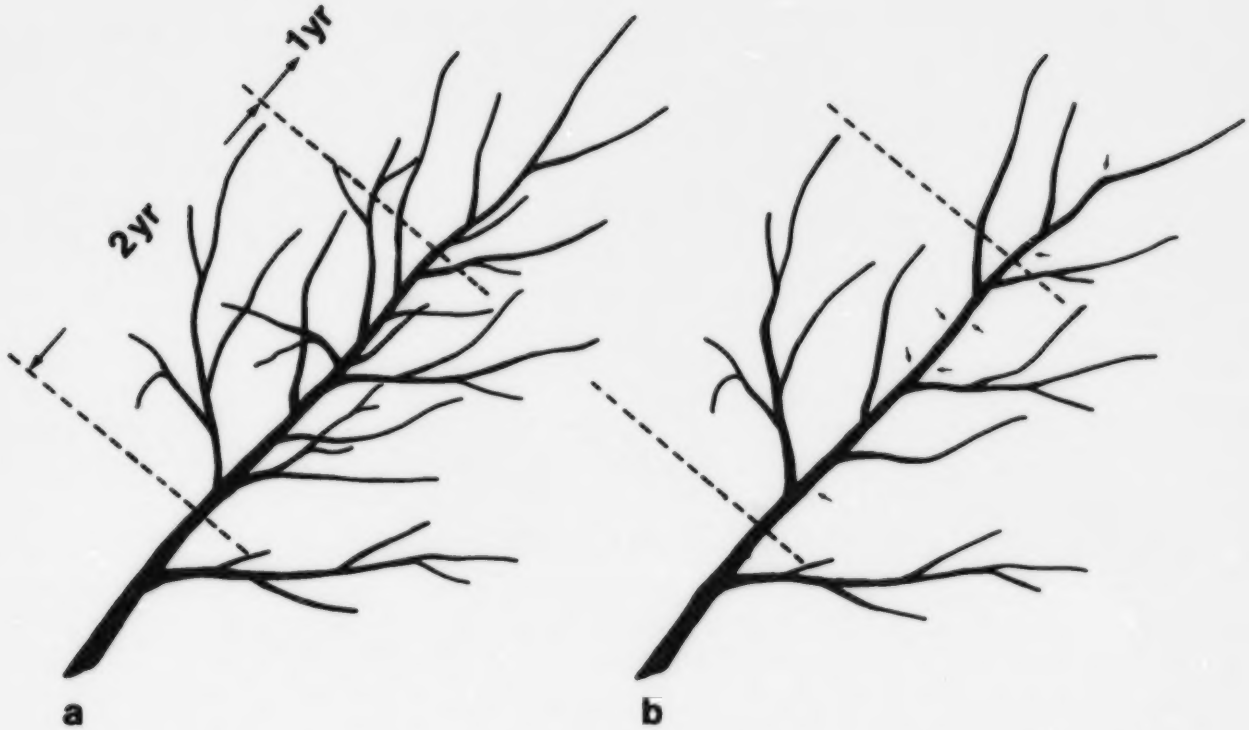


Figure 25. Thinning-out cuts remove overly vigorous, weak or improperly oriented one-year-old twigs with collar cuts. Excessive fruiting wood can be removed to reduce the potential crop load and twigs spaced to avoid internal shading.

Pruning Old Trees

Pruning strategies change with older and declining trees because tree vigor decreases and the full tree canopy is lost to canker or limb breakage. Now different pruning practices will be required. It may be necessary to retain vigorous shoots or upright branches to fill gaps in the canopy or replace weakened scaffold limbs. At times, major heading-back cuts will be needed to encourage a strong renewal of shoot growth within the canopy.

Summer Pruning

Summer pruning can be a useful training tool for newly planted orchards and young trees. Pinch or rub off undesirable growth such as watersprouts or competing shoots while they are still succulent (within six weeks of bud break). This will reduce the number and size of pruning cuts the following year and fewer canker lesions will be formed.

When summer pruning is practiced on mature trees, excessive reduction of tree vigor may result. In comparison to traditionally pruned trees in Ontario, summer pruned trees grow less and produce less fruit. This response is less pronounced if trees are lightly pruned instead of removing half the growing shoot. Summer pruning should be attempted only on vigorous trees where growth might otherwise be excessive. It should not be practiced later than July.

Mechanical Shearing

In high density plantings, the practice of mechanical shearing of exterior shoots during midsummer has been attempted to restrict tree size and to allow more light into the interior of trees. It must be followed by hand pruning the next spring to re-open the canopy. No practical benefits of this practice have been proven. Mechanical hedging of peach trees has been associated with winter injury. In general, the more severe the hedging the greater the degree of winter injury. For this reason, mechanical summer hedging of peach trees is not recommended.

Pear

G. Tehrani

Training and Pruning Pear Trees

Introduction

To insure good crops with an acceptable fruit size, proper training of non-bearing trees and regular, moderate pruning of mature pear trees are necessary. Inadequate pruning will enhance the development of a large number of competing branches on the tree. Too many fruit spurs will eventually be formed on such trees, resulting in the suppression of vegetative growth, poor fruit-set and small fruits. Overpruning will stimulate excessive shoot growth, causing trees to be more prone to fireblight infection, and reduce fruit yield.

Nutrition plays an important role in the susceptibility of pear trees to the fireblight. There should be a good balanee between nitrogen and potassium. Based on leaf analysis data collected in Ontario, foliar nitrogen levels between 2.2–2.4% and potassium levels of 1.3–1.5% reduce the possibility of serious outbreaks of fireblight in pear orchards.

Physiological Aspects of Training and Pruning Pear Trees

In general, training and pruning a pear tree is similar to an apple tree. Like apples, there are some specific points which should be kept in mind while training and pruning different pear cultivars. These points will be discussed when different steps of training and pruning with this crop are discussed. However, the main responses relative to the effects of light on tree form and growth habit, as outlined for apples (pages 7–8) will apply to pears.

Training and Pruning Young Pear Trees

The proper training and pruning of trees at planting time and during their second to third year of growth is similar to apple trees: it is still very critical. At this stage, a proper framework should be established for young trees without delaying the fruiting process. At planting time, all broken, ragged, withered or dead roots should be cut back to live, healthy tissue. This will promote quick healing of wounds and early development of branch roots. While the trees are moved from nursery, a large portion of roots is cut. In order to establish a balance between top growth and the root system at planting time, the tree is severely headed-back and most feathers and branches removed. This will reduce water loss, establish the height of head and set the stage for the training process of the tree. The height of the head will depend on the system of training to be followed.

The recommended system of training for pear trees in Ontario is the modified leader system.

Trees formed according to this pruning technique should have between five and eight scaffold limbs along a central axis and a tree height between 4.5–5.5 m (15–18 feet) at full maturity. The development and selection of wide-crotch angled branches in pear trees is not as critical as it is with apple, cherry and peach trees. However, the use of wooden or metal limb spreaders (Figures 10 and 26) will substantially help the establishment of wide-angled crotches. The early use of limb spreaders in the Anjou and Bosc cultivars has shortened the lead time from planting to production. In Bosc, the crotch angles should not exceed 60°. Otherwise after fruiting the limbs will extend below the horizontal and this condition will encourage suckering. The following steps are recommended for training and pruning pear trees to a modified leader system.

Year one (at planting)

When trees are small and poorly branched, cut the one-year-old whip back to a height of 90 cm (36 inches) and remove all the feathers immediately after planting. On larger trees with well-developed branches, three well-spaced, wide-crotch angled scaffold branches may be left on the tree. In such cases, the first branch must be at least 60 cm (24 inches) above the ground level. The leader must be headed-back 54–72 cm (22–29 inches) above the point of origin of the uppermost scaffold limb. Strong scaffolds left on the tree must be cut back so that their tips are at least 30 cm (12 inches) below the tip of the leader. This will prevent the side branches from competing with the leader.

Year two until bearing

Select three to four wide-angled, uniformly distributed scaffold limbs, about 18–24 cm (7–10 inches) apart, around the trunk (Figure 9). Remove the additional, unwanted branches. Keep the leader dominant. If it is adequately strong, the leader could be headed-back to force a second layer of scaffold limbs. Again, if any laterals are vigorous enough to compete and take over the dominance of the leader, head them back or eliminate these branches (Figure 10). Remove the suckers, shoots and spurs from the main trunk of the tree and the first 30 cm (12 inches) length of all the scaffolds. Repeat the procedure of selecting scaffold limbs in the third spring. By this time, five to eight main scaffold limbs should have been selected on the tree (Figure 11). From this point on, avoid heavy pruning; do not try to open up the tree during the second to third years of growth, as this will only delay flower-bud formation and the onset of fruiting. Most pear trees look crowded during this period, however, as soon as fruiting starts, the trees will open up naturally. After the main scaffold branches are formed, a minimum amount of pruning is needed until the trees have produced crops for at least two years. At this time, with ample fruit spurs on the tree, major corrective pruning can be done without creating an overgrowth and a further postponement of fruiting.

'Anjou' and 'Bosc' trees require different training practices. With 'Anjou', once the main scaffold limbs are selected, no more heading-back on the remaining limbs should be made. With 'Bosc', due to its excessive vegetative growth, more heading-back of the main scaffold branches will be required.

Figure 26. Metal limb spreaders used to position scaffold limbs from 45–60° from the vertical position on three-year-old 'Bartlett' pear trees.

Pruning Mature Trees

Pear trees bear their fruit from terminal buds on short spurs found on two-year and older wood. These fruit spurs are commercially productive for about six to eight years. Pruning will keep the spurs and fruit wood in a healthy and vigorous state and, at the same time, permit plenty of sunlight and air into the tree. Regular pruning will also prevent overbearing, encourage new growth, permit spray penetration and improve fruit size and quality.

Among deciduous fruit species, which have been properly trained, mature pear trees require the least amount of pruning. Most pruning consists of thinning-out cuts after the trees have cropped for at least two consecutive years. Leave branches which are in the horizontal orientation, providing these do not interfere with movement in the orchard. If tree height exceeds 4–5 m (13–16 feet), then remove the uppermost vertical branches back to strong lateral scaffolds at the desired height. Whenever large cuts are made, considerable suckering will result at the point of the cut. These suckers should be removed early in the summer by rubbing them off. Otherwise, these sprouts may become infected with fireblight and cause serious damage or even death to the tree.

Older trees which have not been pruned regularly, should be pruned enough to remove thick and interfering branches, old unproductive spurs and dead wood. Normally, with this type of pruning, new shoots and spurs will be stimulated resulting in better cropping and fruit size. It might be necessary to rejuvenate trees 20-years-old and older, depending on their state of vegetative growth. This refers to the uniform removal of about 20 to 25% of the old spurs on the branches by knocking them off or cutting them with pruners. This will force the remaining spurs into an active vegetative state. It will stimulate more leaves per spur, better fruit size and good production for several more years.

Plum

European & Japanese

G. Tehrani

Training and Pruning Plum Trees (European and Japanese)

Introduction

Most European plum cultivars are upright in growth habit. This is especially evident with young trees prior to the onset of fruiting. Japanese plum cultivars are either upright or more spreading like peach trees. Damson plums are very upright in growth and are less inclined to spread than either European or Japanese. The training and pruning of European plums should be aimed at developing trees which are spreading and easily harvested either mechanically or by hand, producing adequate and good quality fruit as early as possible after planting and reducing the pruning costs.

In general, the European and Damson plums will require very little heading-back. Pruning will consist mainly of thinning-out cuts. More watersprouts or suckers will grow on European and Damson than on Japanese plums. These should be removed annually, maintaining only the scaffold limbs and the lateral shoots which are developing on the tree. Frequent and heavy thinning-out of the shoots should be avoided on young vigorous plum trees. This will encourage the development of too many shoots on the tree.

Training and Pruning Young Plum Trees

The following steps are recommended for training and pruning plum trees to a **modified leader system**:

Year one (at planting)

At planting time, the leader should be headed-back to 90 cm (36 inches) in height, feathers removed and all secondary branches cut back, leaving the buds on the tree trunk intact. During the first growing season, several scaffold limbs should develop within 35–45 cm (14–18 inches) of the top cut. In summer, when the lateral shoots have grown 8–12 cm (3–5 inches) in length, use rounded toothpicks, or weighted or standard spring clothespins to direct the new growth at 45–60° in relation to the central leaders (Figure 16).

Year two

Select three scaffold limbs with wide-crotch angles which are evenly spaced around the trunk (Figure 19). No branch should be directly above a lower one and branches should be 15–18 cm (6–7 inches) apart along the trunk. Head-back the selected scaffolds to from 60–80 cm (24–32 inches) in length but leave the uppermost scaffold the longest. If the selected scaffold limbs are crowding the leader, use wood or wire limb-spreaders to establish the desired crotch angle (Figures 10 and 26).

Year three

To start the second layer of scaffold branches, select two branches on each of the main scaffolds. Ideally, these secondary branches should be 15–18 cm (6–7 inches) apart along the branch from which they are emerging. All newly selected scaffolds should be headed-back to about 60–80 cm (24–32 inches) in length. The upper secondary branch should be left 10–15 cm (4–6 inches) longer than the lower branches.

Year four and later

Repeat the procedure outlined above under Year three. Remove branches which are competing with each other and head-back the upper branches to an outward-growing lateral bud. During the fourth and fifth years, most plum cultivars will produce fruit. It is recommended that no more corrective pruning should be performed until the trees have cropped for two years. In the sixth year, thin out unwanted branches and continue to prune the mature trees in the manner outlined below.

Pruning Mature Trees

Flowers on plum trees are initiated on lateral buds of the current season's growth and vigorous spurs on wood two- to eight-years-old. The simple buds produce one or two flowers and no leaves accompany the flowers. Fruit spurs on European plums are frequently branched and are longer and more slender than those of Japanese types.

Generally, bearing European plum trees require very little pruning. Make enough thinning-out cuts to maintain adequate growth on the lower branches. Remove dead, weak, broken, black-knotted and crossover branches. Special attention should be paid to the pruning of **black knots** in plums. During dormant pruning (not later than March) remove all the black knot cankers 15 cm (6 inches) below the knot. Collect and burn all pruning wood bearing black-knot cankers. Knots left lying on the ground are a source of spores and will start new infections. Inspect the plum trees several times during the growing season for new knots and remove and burn those that were missed in dormant pruning.

Japanese plum cultivars such as 'Early Golden', 'Methley', 'Shiro' and 'Burbank' grow with a more spreading growth habit than European plums. Also, these plums have a tendency to overproduce. To insure good fruit size, prune the bearing trees annually, thinning out a large number of twigs. However, even with proper pruning of Japanese plum trees, adequate fruit thinning should be practiced to achieve good fruit size. With Japanese plums, many small cuts are more desirable than a few large ones. As a rule of thumb, about 10% of the bearing surface should be thinned out annually.

Summer Pruning and Shearing

European and Japanese plums

No summer pruning is recommended with either European or Japanese plums.

For several years, European plum trees were sheared at Vineland about seven weeks after full bloom. Summer shearing reduced yield, growth and the crop efficiency index but did not affect fruit size.